THE

Tea Research Institute

OF

Ceylon.

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BULLETIN No. 8

Annual Report for the Year 1931.

Published by

THE TEA RESEARCH INSTITUTE OF CEYLON.
VICTORIA COMMEMORATION BUILDINGS, KANDY.

The Tea Research Institute of Ceylon.

BOARD OF CONTROL.

(A) Representing the Planters' Association of Ceylon:—

(1) Mr. R. G. Coombe (Chairman).

(2) Mr. Jas. Forbes (Jnr.),

(3) Mr. J. Horsfall.

(B) Representing the Ceylon Estates Proprietary Association:-

(4) Mr. J. D. Finch Noyes.

(5) Major J. W. Oldfield, M.C., C.M.G., O.B.E., M.S.C.,

(6) Major H. Scoble Nicholson, O.B.E.

(C) Representing the Low-Country Products' Association:—

(7) Mr. C. H. Z. Fernando.

(D) Representing the Small-Holders:—

(8) Mr. D. H. Kotalawala, M.S.C.

(E) Ex-Officio Members:—

(9) The Hon. the Financial Secretary.

(10) The Director of Agriculture.

(11) The Chairman, Planters' Association of Ceylon.

(12) The Chairman, Ceylon Estates Proprietary Association.

Secretary, Mr. A. W. L. Turner, Victoria Commemoration Buildings, Kandy.

SIXTH ANNUAL REPORT

OF THE

BOARD OF THE TEA RESEARCH INSTITUTE OF CEYLON

FOR 1931.

Foundation:—The Institute was established and the Board of Management incorporated by Ordinance No. 12 of 1925, dated the 27th October, 1925.

Board of Management:—On the 1st January, 1931, the Board of Management consisted of the following Members:—

Chairman:—Mr. R. G. Coombe.

Ex-Officio Members.

The Hon'ble the Financial Secretary, (Sir Wilfrid Woods, C.M.G.).
The Director of Agriculture, (Dr. W. Youngman, D.Sc., Ph.D.).
The Chairman, P.A. of Ceylon, (Mr. A. G. Baynham).
The Chairman, C. E. P. A., (Mr. F. F. Roe).

Representatives of the P. A. of Ceylon.

Mr. R. G. Coombe.
Mr. John Horsfall.
Mr. Jas. Forbes (Jnr.)

Representatives of the C. E. P. A.

Major J. W. Oldfield, C.M.G., O.B.E., M.C., M.S.C.
Major H. Scoble Nicholson, O.B.E.
Mr. J. A. D. Finch Noyes.

Representative of the L. C. P. A.

The Hon'ble Mr. D. S. Senanayeke, M.S.C.

Representative of the Small-holders.

The Hon'ble Mr. T. B. Panabokke, M.S.C.

Secretary:—Mr. A. W. L. Turner.

Mr. F. F. Roe retired from the Chairmanship of the Ceylon Estates Proprietary Association on the 16th March, and was succeeded by Mr. G. K. Stewart.

Mr. G. K. Stewart proceeded on furlough from the 12th May to the 31st October; Mr. R. D. Morrison acted for him on the Board during his absence.

Mr. John Horsfall proceeded on furlough from the 1st June to the 10th October, and Mr. Gordon Pyper was nominated by the Planters' Association of Ceylon to act for him during his absence.

The Hon'ble Mr. D. S. Senanayeke resigned his appointment on the Board as from the 26th October, and the Low-Country Products Association nominated Mr. C. H. Z. Fernando to fill the vacancy.

Mr. Jas. Forbes (Jnr.) proceeded on leave in November and Mr. C. C. du Prè Moore was elected by the Planters' Association to act for him during his absence.

In accordance with Ordinance No. 12 of 1925, Section 5 (1) B, the Nominated Members retired on the 31st December, 1931, having completed their three years' term of office. All the Associations concerned re-nominated their members, and His Excellency the Governor nominated Mr. D. H. Kotalawala, M.S.C., as the Representative of the Small-holders.

Rules of the Board of the T. R. I.—Travelling Allowances:—At a Meeting of the Board held on the 19th January, it was decided that the travelling allowances of the Members of the Board and the Scientific Staff should in future be paid according to the revised mileage rates for Motor Vehicles, in accordance with Government regulations. Rule No. 8 has been duly altered.

STAFF OF THE T. R. I.

Senior Scientific Staff:—Dr. D. I. Evans, Biochemist, proceeded on nine months' furlough as from the 11th March, and resumed his duties on the 21st December.

Mr. T. Eden, Agricultural Chemist, proceeded on 9½ months' leave as from the 16th December.

Junior Scientific Staff:—Mr. G. D. Austin was appointed Assistant Entomologist as from the 1st October.

Mr. C. A. de Silva was appointed Research Assistant to the Agricultural Chemist as from the 1st March.

Mr. M. H. E. Koch was appointed Assistant to the Plant Physiologist on the 1st September, succeeding, Mr. D. J. Welaratne, who was appointed Junior Assistant in that Department on the 1st February, and left the Institute's services on the 31st August.

Mr. D. Nicol was appointed Field Assistant in the same Department from the 1st August.

JUNIOR STAFF PROVIDENT FUND.

This Fund was established as from the 1st January, 1931, for the Institute's Junior and Subordinate Staffs. The Board makes a contribution to the Fund equivalent to 5% of the salary of the Employee, who must contribute a like amount.

In accordance with the Rules of the Fund, the following were elected as Trustees of the Fund :—

Mr. R. G. Coombe, (Chairman, T. R. I.).
Dr. Roland V. Norris, D.Sc., F.I.C. (Director, T.R.I.)
Mr. Jas. Forbes (Jnr.), (Member of the Board, T. R. I.).
Mr. B. N. Sastri, (Member of the Junior Staff, T. R. I.).

ST. COOMBS ESTATE.

Visiting Agent:—Mr. J. W. Ferguson returned from furlough in February and relieved Mr. J. E. B. Baillie-Hamilton, who was acting for him.

Superintendent:—During the course of the year the Board entered into a five-year agreement with the Superintendent similar to that of the Senior Scientific Officers of the Institute.

The average gross price obtained during the year for St. Coombs teas was Rs. 1/06 as against the Colombo market average of -/80 cents. A graph illustrating the comparison between the St. Coombs prices and the Colombo market average prices for high-grown teas, is attached herewith.

A copy of the Visting Agent's Review on the work done on St. Coombs during the year is attached.

CONFERENCE OF THE T. R. I.

The Second Conference of the Institute was initiated by His Excellency the Officer Administering the Government, Sir Bernard Bourdillon, K.B.E., C.M.G., on Thursday, the 25th February; and on the morning of the same day, His Excellency formally opened the new Laboratories of the Institute.

MEETINGS OF THE BOARD.

The Board of Management held four meetings, two in Colombo and two in Kandy. The average attendance was 9.

COMMITTEES.

The Experimental and Estate Sub-Committee:—At a Meeting of the Board held on the 29th January, the Experimental Sub-Committee and the Estate Committee were amalgamated and designated "The Experimental and Estate Sub-Committee". This Committee comprises the following members :—The Director, T. R. I., The Chairman, T. R. I., The Visiting Agent of St. Coombs, The Superintendent of St. Coombs, Messrs. John Horsfall, C. Huntley-Wilkinson, and the Agricultural Chemist, T. R. I., (Convener).

This Sub-Committee met on four occasions.

The Finance Sub-Committee:—This Sub-Committee was appointed on the 29th January.

Personnel;—The Chairman, T. R. I.; The Chairman, Planters' Association of Ceylon, The Chairman, Ceylon Estates Proprietary Association, and the Director, T. R. I.

This Sub-Committee met on four occasions.

NETTLE GRUB.

The thanks of the Board are due to the Department of Agriculture for having seconded Mr. G. D. Austin for special duty in connection with Nettle Grub in the Uva District for a further period of six months till the 30th September.

Mr. Austin was taken on to the permanent Staff of the Institute on the 1st October, and the Uva District Planters' Association with the agreement and assistance of the Ceylon Estates Proprietary Association levied a cess upon estates in that district and collected the necessary sum to compensate Mr. Austin for the loss of pension rights on transferring his services to the Institute.

EMPIRE MARKETING BOARD.

Up to date the Institute has expended a sum of £500-0-0 of the grant of £1,000-0-0 made by the Empire Marketing Board for the purchase of small-scale machinery. Four experimental machines are required for the whole scheme, so far only two have been purchased. The balance of the machinery will be ordered when the present machines have been fully tested out and it has been discovered what alterations, if any, are required.

With regard to the Institute's application to the Empire Marketing Board for a grant of £2,000-0-0 per annum for three years to provide for the appointment of a trained Entomologist for parasitological work on insect pests of tea and other crops in Ceylon, the Secretary of State for the Colonies has written that in view of the present financial position it is unlikely that the Empire Marketing Board will be able to recommend the proposed grant.

AFFILIATION WITH THE UNITED PLANTERS' ASSOCIATION OF SOUTHERN INDIA.

A deputation from the U. P. A. S. I. visited Ceylon to discuss the possible future rapprochement between the Tea Scientific Department of the U. P. A. S. I. and the Tea Research Institute of Ceylon.

Two Conferences were held at which members of the Deputation and Representatives of the Tea Research Institute were present. The matter of affiliation was discussed at length at both these Conferences and the whole case was referred to the various responsible bodies in Ceylon and in England. The Board subsequently decided that owing to the uncertain position of the Tea Industry in Ceylon and in South India and the consequent difficulties likely to be experienced in financing any such scheme, further consideration of the proposal should be deferred.

18TH REPORT OF THE IMPERIAL ECONOMIC COMMITTEE—TEA.

The Director in collaboration with his staff, wrote two memoranda dealing with Section XIII of the above Report. These were forwarded to Mr. F. A. Stockdale for transmission to the proper quarter, and have also been published in *The Tea Quarterly*.

PUBLICATIONS.

The number of copies of the Publications of the Institute issued during the year averaged 1,389 copies per issue. In addition 67 copies were supplied on an exchange basis with other Research Institutions.

To date the Institute had issued six bulletins and four volumes of *The Tea Quarterly*.

All estates paying the Cess are entitled to receive free of charge copies of all Publications if they register their names with the Secretary.

Other persons desiring to receive the Publications can register their names with the Secretary on payment of the following annual subscription :—

Rs. 15-00 for those resident in Ceylon.
Rs. 15-25 for those resident in India.
£1-5-0 for those resident elsewhere.

Single copies of the Publications are available at Rs. 2-50 or four shillings each.

No spare copies of the following Publications are available :—
Bulletins Nos. 2 and 3.
The Tea Quarterly Vol. II, Parts 1 and 2.
,, ,, Vol. IV, ,, 1 and 2 (Double Numbers).

ADVERTISEMENTS.

At a Meeting of the Board held on the 23rd October, it was decided that advertisements should be accepted to *The Tea Quarterly*. All enquiries in this connection should be addressed to the Director, Tea Research Institute of Ceylon.

FINANCE.

The audited Statement of Accounts is attached.

A. W. L. TURNER,
Secretary.

REPORT

ON

ST. COOMBS ESTATE

FOR THE YEAR 1931.

Superintendent:—Mr. John A. Rogers.

Season 1931 was exceptionally wet and not too favourable for crop. The crop harvested was 13,629 lbs. Made Tea, being 1,421 lbs. ahead of 1930 crop, and represents a yield of 672 lbs. per acre as against 680 lbs. per acre in 1930. The yield per acre is slightly lower on account of 4 acres of young tea having been included in tea in bearing acreage, when the bungalow sites were completed.

Rainfall:—To 31-12-31.	112·79 inches.	No. of wet days 231.
To 31-12-30.	88·77 inches.	No. of wet days 187.
Increase	24·02 inches.	No. of wet days 44.

Expenditure:—Cost of Production was :—

Estimated Cost Revenue Account 66·36 cts : Actual Cost 61·08 cts.

Estimated Cost Capital Account 28·15 cts : Actual Cost 29·51 cts.

The profit for the year, before deducting capital expenditure, was Rs. 40,565-38.

Manufacture:—Nett average for 1931. -/94.78 cents.
Nett average for 1930. 1/08.00 cents.

St. Coombs teas continue to hold a high position on the Colombo Market.

Outside Leaf Manufactured:—

For Mattakelle	4,708 lbs. Made Tea @ -/07 cents.
For Holmwood	59,927 lbs. Made Tea @ -/17 cents.

Old Clearing:—These were supplied with 37,944 two year old stumps from the St. Coombs Nurseries, and are doing extremely well. The White Grub, which caused so much damage in the early stages, has not been in evidence during the year under review. This may be the result of cultivation, or to the collecting of Grubs which took place about the end of 1929.

On the New Clearing there has been no sign of the White Grub, and this I should say, was due to the forking of the Patnas before planting.

All bushes of a suitable size on the old clearings were centred in September and have come away very well.

The *Tephrosia Vogelli* put out in 1930 has shewn good growth and has been a great protection to the tea during the present drought, besides

giving a good amount of green matter which was forked in at the time of applying the Mixture.

New Clearing:—Acreage, 28·2·35,
Treatment, Patna forked in
Drains, 2½ acres Bunded, Balance Bagot reverse slope
Cost Rs. 301/28 per acre.

This clearing was planted with two-year-old stumps, with the exception of the experimental plot which is under the direct supervision of the Institute Staff.

The clearing was given a small application of Niciphos, 1 cwt. per acre, on December 21st to 26th, and is doing remarkably well in spite of a severe drought. This clearing is a fine piece of work and reflects credit on the Superintendent.

Tea Nurseries.—New Nurseries were opened during the year and there will be sufficient plants for our requirements.

Buildings:—During the year there were built Engine Driver's quarters. and Tools and Manure Shed.

Factory:—All Electric Plant was inspected and tested during the year and reported on as in excellent order.

General:—The Estate all over has improved, and it only requires a little more time before the old tea will be in first class order.

Cost:—Which has been high owing to the arrears of work which had to be got up with, will in the near future be considerably reduced.

(Sgd.) JAMES W. FERGUSON.

St. Clair,
Talawakelle,
February, 1932.

REPORT

OF

THE DIRECTOR,

TEA RESEARCH INSTITUTE OF CEYLON

FOR 1931.

Staff:—Dr. Evans was on home leave from the 11th March to the 21st December during which period Mr. B. N. Sastri was in sub-charge of the Biochemical Division, working under the general supervision of the Director.

Dr. Gadd was away for three months during the year when the work of the Mycological Division was in the charge of Mr. Tubbs.

Mr. Eden proceeded on home leave on the 16th December. No additions were made to the Senior Staff.

The Junior Scientific Staff was increased by five during the year, Mr. G. D. Austin being transferred from the Department of Agriculture in October on his appointment as Assistant Entomologist, Mr. C. A. de Silva being appointed Research Assistant to the Agricultural Chemist, while three Field Assistants were appointed. The Junior Staff, therefore, numbered twelve at the end of the year, nine working at Headquarters, and three at the Nettle Grub Sub-Station, Passara.

The thanks of the Institute are due to the Ceylon Estates Proprietary Association through whose agency funds were provided to compensate Mr. Austin for his loss of pension on leaving Government Service.

A Provident Fund was established for the benefit of the Junior and Subordinate Staff.

Laboratories and Buildings:—The new laboratories, which were occupied in December, 1930, were completed early in the year and were formally opened by His Excellency the Officer Adminstering the Government in February, on the occasion of the Institute's Second Conference. Demonstrations illustrating the work of the Institute were arranged in the various Departments and a large number of visitors availed themselves of the opportunity to inspect the buildings.

An insect breeding house and a fumigation chamber were the only new buildings added during the year, no additions being made to the Senior or Junior Staff Bungalows.

Estate:—The new water supply was taken into use early in the year. The quantity of water available has proved adequate for all requirements, but the liability of the supply to contamination has been a source of considerable anxiety, and much trouble has been experienced with the chlorination plant installed. Little could be done to the laboratory cart road owing to lack of funds and this road is now in urgent need of repair.

Most of the building sites have now been cleared up, banks grassed, trees and hedges planted. This work has been in charge of Mr. Tubbs.

Regular meteorological observations were taken throughout the year and the records sent to the Colombo Observatory. The weather was very unfavourable, the rainfall, 113·73 inches, being considerably in excess of normal with little or no break between the two monsoons.

Conference:—The Second Conference of the Institute was held at St. Coombs on the 25th and 26th February and was attended by more than two hundred planters. On the first day, the proceedings were inaugurated by His Excellency Sir Bernard Bourdillon, K.B.E., C.M.G., the chair subsequently being taken by Mr. A. G. Baynham, Chairman, P. A. of Ceylon, while Mr. C. H. Z. Fernando, Chairman, the Low-Country Products Association, presided on the second day.

After a general review of the Institute's programme of work by the Director, papers were read by Mr. Eden on "Cultivation and Soil Improvement"; by Mr. King on "Control of Insect Pests"; by Mr. Tubbs on "Some Physiological Aspects of Pruning"; by Dr. Gadd on "The Pruning of Tea in Relation to Disease"; and by Dr. Evans on "Factors in Tea Manufacture".

All these papers gave rise to very valuable discussions, a full report of which will be found in *The Tea Quarterly* Conference Number, May, 1931.

The afternoon of the second day was left free for visitors to inspect the factory and estate when large numbers availed themselves of the opportunity.

Visitors' Day:—A large number of planters and other interested persons visited the laboratories and factory during the year. If visitors could conveniently arrange their visits for the first Wednesday in the month, which has been set aside as a special Visitors' Day, it would be a convenience to the Staff and minimise any interuption of work.

Library:—The facilities available at St. Coombs have made it possible to organise the Institute's Library on a proper basis. Dr. Gadd has been in charge of the library throughout the year and has spent much time and trouble in classifying the large number of scientific journals and miscellaneous publications which had accumulated since the library was formed. With the co-operation of the other scientific libraries in Ceylon a list of the chief scientific journals available in Ceylon was compiled. This will greatly facilitate access to many scientific papers and prevent unnecessary expenditure on journals which are already available in other local libraries.

Publications:—The demand for the Institute's publications continues steadily to increase and many of the earlier numbers of *The Tea Quarterly* are now exhausted. Applications for publications should be made direct to the Secretary at Victoria Commemoration Buildings, Kandy, and *not* to St. Coombs.

The Director would be glad to receive papers on practical planting matters for inclusion in *The Tea Quarterly*.

Small-Holders:—A Sub-Committee was appointed by the Board during the year to consider methods by which assistance could be afforded to small-holders in tea and steps were taken to obtain details of the number and

size of the holdings in various areas. These returns are not yet complete but it is obvious that the number of holdings is much larger than is, perhaps, generally realised. The question of assistance is very much complicated by the small size of individual holdings, a large percentage of which are less than one acre in area. With such small units, and in the present depressed state of the tea industry, it is obvious that opportunities for improvement are very much limited by the economic position of the holder.

Empire Marketing Board:—Owing to the financial condition in England and the consequent reduction in the funds at the disposal of the Empire Marketing Board there was some doubt whether the Institute would receive the unexpended balance of the grant of £1,000 sanctioned for the purchase of small-scale tea machinery. Late in the year, however, intimation was received from the Empire Marketing Board that the money would be available.

It has not, however, been possible to obtain the grant for an entomological survey.

Co-operation with Indian Research Stations:—The Chief Scientific Officer of the Tocklai Experimental Station and the Director of the Nelakotta Laboratory, S. India, both attended the Institute's Conference and the opportunity was taken to discuss with both officers the work in progress in Ceylon and India. Touch is also maintained between the three stations by correspondence between the Scientific Staffs. An invitation for Mr. Eden to visit Tocklai was received, but this could not, unfortunately, be taken advantage of owing to Mr. Eden's absence on home leave. There can be no question that much is to be gained by the fullest co-operation between all Tea Research Stations and everything possible will be done to maintain this.

The question of affiliation between the Tea Research Institute and the South Indian Research Station, which had been discussed late in 1930 between representatives of the U. P. A. S. I., and the Tea Research Institute, was further considered early in the present year. Owing to the uncertainty of the tea position and the difficulties involved in financing any such arrangement, it was ultimately decided not to proceed further with the scheme at the present time.

Tea Seed:—Arising from tht 18th Report of the Imperial Economic Committee, the opinion of the Institute was sought in regard to the proposal made for the establishment by Government of Tea Seed gardens at high elevations. The Institute was unable to support this proposal. In the present state of knowledge regarding the influence of jât on quality and other factors, no guarantee could be given that such seed gardens would provide material in any way superior to that already available.

In agreeing with the necessity for work on the improvement of plant material the Institute also expressed the opinion that genetical work on tea was unlikely to give results of value in a reasonable period of time and suggested that work on the vegetative propagation of tea should receive prior consideration.

WORK OF THE STAFF.

There was a considerable increase in the correspondence of the Director's Office which comprised 3,412 letters in and 3,529 letters out.

Meetings of the Dimbula, Dickoya, Dolosbage, Uva, Sabaragamuwa and Haputale Planters' Associations were attended by members of the Staff. The Director will be glad to arrange for lectures by the Staff at such meetings if desired and provided ample notice be given.

The Director also attended the meetings of the Estate Products Sub-Committee.

Advisory Work:—A feature of the year was the very large increase in the number of applications for advice made to the Institute as compared with previous years. This was apparent in all sections and was reflected in the large number of estates visited by members of the Staff, such visits amounting to 131.

Mycology:—Though the number of specimens received for examination and report again showed an increase, fungus diseases were not more prevalent than usual and no new diseases of tea were recorded. Poria has again been the most common root disease up-country, doubtless owing to the highly-resistant nature of the causative fungus and the difficulty of eradicating this from the soil. In view of the fact that sulphate of iron had been suggested as a useful remedy, trials have been made with this substance but the laboratory experiments do not suggest that this is likely to be at all effective.

Further work by the Mycologist in collaboration with the Agricultural Chemist has confirmed the association between "Bitten-off" disease and an alkaline condition of the soil. This finding explains why this condition is not infrequently found in nurseries located on sites of old cooly gardens. In such cases the application of sulphur at the rate of 10 cwt. per acre is likely to be efficacious.

A good many cases of "Witches Broom" have been reported and there seems some evidence that this disease is increasing in prevalence. The cause still remains quite obscure and attempts in the laboratory to transmit the disease by grafting or similar methods have given negative results. Fuller details will be found in the Report of the Mycologist.

Several cases have also occurred of a leaf disease of Crotalarias caused by the Fungus *Parodiella grammodes*. Affected plants should be burnt and seed should not be collected from them.

The Mycologist has commenced a study of the nodule organisms of local leguminous green manure plants. There is some reason to believe that the difficulty in establishing such crops may, in some cases, be due to the absence of the appropriate organism in the soil and this investigation will throw light on this possibility and may provide a remedy if the above theory be substantiated.

Entomology:—Under insect pests, Tortrix was somewhat more prevalent than in the previous year. Work has continued on the breeding of the Tortrix parasite, *Trichogramma*, and a new insect breeding house has been

constructed for this work. Considerable difficulty has been experienced in maintaining a supply of moth eggs for parasitisation, but one species of moth, *Corcyra cephalonica,* now seems likely to yield more favourable results. The indigenous species of *Trichogramma* have not proved particularly convenient for multiplication owing to their somewhat large size. It has recently been possible, however, to arrange for the importation of a different and smaller species, *T. minutum,* which has been successfully bred on the large scale in America and elsewhere, and it is hoped with the arrival of this species in January that the difficulties hitherto experienced will largely disappear.

Nettle Grub has continued a serious pest in some parts of the Uva District, particularly Passara. In consequence arrangements were made for more intensified work on this subject. Additional accommodation has been secured at Passara, providing room for a field laboratory and quarters for two further Field Assistants who were appointed in May. Mr. Austin continued in charge of this work and was transferred from the Agricultural Department to the Institute's Staff in October. Thanks are due to the Ceylon Estates Proprietary Association for financial arrangements which rendered this possible.

Much time has been spent on a study of the life-history of the different species of Nettle Grub and in a search for possible parasites, while the effectiveness of different sprays has been investigated. So far spraying with laundry soap and water (1 lb. to 40 gallons) is as effective as, and more economical than, anything else. In view of the difficulty and cost of spraying large areas, early recognition and treatment of an attack is of the highest importance.

To facilitate this it was decided to proclaim Nettle Grub as a Pest under the Plant Pest Ordinance No. 10 of 1924 and this has now been done. The declaration, which applies only to the Uva Province, provides for the notification of all attacks and for the collection of the cocoons.

To obtain accurate and prompt information of outbreaks the Institute has hitherto relied on printed postcards, to be filled in and returned monthly, which were issued to 126 estates in Uva. This has not, however, proved altogether satisfactory as only about half these estates have sent in regular returns.

In view of the importance of the biological control of Tortrix and Nettle Grub it is disappointing to have to report that owing to a reduction in the funds at the disposal of the Empire Marketing Board due to the economic depression, it has not been possible to obtain the grant for which the Institute had applied to cover the cost of a general survey in Ceylon of insect pests and their parasites.

Plant Physiology:—As mentioned in last year's report, a study of pruning in all its aspects forms the major line of investigation in this section. Field experiments to examine the influence of three different types of pruning, of the time of pruning, and of elevation have been initiated. To investigate the last factor the St. Coombs experiment, elevation 4,600 feet, is to be replicated at Peradeniya, 1,500 feet, and at Galatura Estate,

Kiriella, 200 feet. The thanks of the Institute are due to the Director of Agriculture and to the Amalgamated Tea Estates Company, Ltd., and their Agents, Messrs. James Finlay & Co., Ltd., for providing generous facilities for work in these areas.

Details of this important experiment will be found in Mr. Tubbs' report. Full records are being maintained of the yields of leaf from each treatment and the influence of the treatment on the quality of the resulting tea will also be examined.

The influence of the removal of the seed shell on the germination of tea seed has been examined and the conclusion reached that the best compromise is to crack the shell before putting out the seed. The importance of a thorough physiological study of the tea bush has continually been stressed and the work now in progress on the reaction of the bush to various treatments and different environmental conditions should do much to put estate practice on a more rational basis.

A better classification of the numerous tea seed races has long been desirable and a considerable number of seed samples from Ceylon, Java, Russia, etc., have been collected and planted out for a study of the characteristics of the different varieties. A block of land has also been reserved for further work on selected jâts.

Mr. Tubbs was, in addition to his own duties, in charge of the Mycological Section for three months during the Mycologist's absence and took over the supervision of the Agricultural Chemist's field experiments when that Officer proceeded on home leave in December.

Agricultural Chemistry:—The urgent necessity for economy, with the consequent curtailment of manurial programmes, has been reflected in the number of enquiries received relative to fertilisers and green manure crops. In regard to the latter it is perhaps advisable to correct a somewhat common misconception that the growth of such a crop necessarily adds considerable amounts of fresh nitrogen to the soil. In the case of a leguminous crop additional nitrogen is, of course, obtained by fixation from the air through the agency of the nodule organisms, though the amount so fixed under tea soil conditions is at present rather an unknown quantity. In the case of non-leguminous crops the nitrogen in the crop is all derived from the soil and the forking in of the crop only returns this nitrogen to the soil. This is not, however, an argument against the use of such crops which definitely conserve the nitrogen supply in addition to the other benefits conferred.

The cover crop demonstration plots suffered badly from weather conditions, drought early in the year being followed by continuous and excessive rainfall. Of these so far tried some seven species are sufficiently promising for trial on a larger scale. Details will be found in Mr. Eden's report. In this connection one must again urge the desirability of estates setting aside small areas for the *trial* of different cover crops. Were this done on a reasonable scale there would soon be available data as to the species most appropriate for different districts and the complaint that suitable cover crops are not available would be heard less frequently.

Further experiments in connection with soil erosion have also been laid down on the new clearing, where three types of drains have been put in on an experimental area of two acres. Measurements of run-off will be made in the coming monsoon. The arrangement of the plots is also such that it will be possible to compare the behaviour of burnt and unburnt areas in regard to percolation and losses of organic matter and nitrogen.

The manurial plots, nitrogen and potash experiment, have now been under observation for a year. A striking feature of these experimental plots, which bears ample evidence to the care and forethought expended in their design and organisation, is the very low experimental error for the means of treatments which, in the case of comparisons between different quantities of nitrogen or potash, is less than two per cent.

The two points which emerge as the result of the first year's trial are (1) The ineffectiveness of the pruning mixture applied at the time of pruning and (2) the small difference shown between the three forms of nitrogen used—blood meal, cyanamide and sulphate of ammonia.

The above conclusions must at present be regarded as tentative in view of the unfavourable climatic conditions which prevailed during so much of the year which might have tended to mask any differential effect. If confirmed, however, it is obvious the implication of these results must be of very wide practical importance. The experiment is further discussed in Mr. Eden's report.

Reference must be made here to interesting results which have been obtained in this section on the effects resulting from soil alkalinity. As is well known, tea requires an acid soil and in cases where an alkaline reaction prevails, certain characteristic pathological symptoms have been proved to follow. The frequent occurrence of "Bitten-off" disease in nurseries located on old cooly garden sites where the soil is often of alkaline reaction is thus explained. Such damage is not, however, confined to nurseries and one instance occurred where a whole estate, situated on the limestone belt, was found almost uniformly unsuitable for the growth of tea.

Biochemistry and Tea Manufacture:—The Biochemical Section has been repeatedly called upon for advice on various aspects of tea manufacture and a large number of factories was visited during the year. More than four hundred tea samples were also received for examination, chiefly in respect of firing conditions. This was largely due to frequent complaints from London of "soft" teas, accompanied by instructions for higher firing. The examination of the firing conditions in many of the factories concerned, however, indicated that the fault was generally in the opposite direction, the teas being submitted to too high a temperature in the initial stages of drying. Such conditions lead to case hardening and such teas, though appearing properly fired at the time of packing, deteriorate on storage owing to moisture being retained in the interior of the leaf. Another common defect observed was too long exposure of the tea before packing. Fired tea very readily picks up moisture during picking over and grading and even in the bins if these are faulty, and from the samples received it is obvious that teas are in many cases packed with too high a moisture content. Tea when packed should contain from 5 to 6% of moisture. If the moisture

content is too low the tea does not mature, while if it is too high the tea frequently grossly inaccurate and also in many cases so cited that they content is, therefore, obvious, as only by a knowledge of these figures can it be decided whether final firing is desirable or not.

A striking feature of the factory inspections made is the very wide variation obtaining in firing conditions, the output from the same type of drier exhibiting the most marked fluctuations. Construction faults in driers are frequent and the whole position in regard to firing is somewhat unsatisfactory. Attention must also be called to drier thermometers which are frequently grossly inaccurate and also in many cases so sited that they do not really indicate the firing conditions obtaining in the drier.

Two small-scale rollers, one sifter and one drier have been in use during the year and have been employed for experimental purposes. Leaf from the manurial plots has been regularly manufactured on this plant in order to investigate the influence of the manurial treatment on the quality of the tea. So far, however, little or no difference in quality has been noticeable between the "no-nitrogen" and "double-nitrogen" plots. Leaf from the nitrogen treated plots, however, tends to wither more rapidly than leaf from the control plots and this interesting point is being further examined. Other experimental work has included an examination of the influence of the period and conditions of fermentation, details of which will be found in the Report of the Biochemist. On Dr. Evans' return from leave late in the year arrangements were made for a systematic investigation of withering conditons, with particular reference to the duration of withering and the effect of artificial withering conditions.

Acknowledgments:—It is a pleasure to acknowledge once again the cordial co-operation of so many planters and the hospitality extended to members of the staff during their tours.

Thanks are due to the Director of Agriculture and the Staff of the Department for the assistance so freely given on many occasions and particularly in the arrangements for the pruning experiment at Peradeniya. As previously mentioned, the Amalgamated Tea Estates Company, Ltd. have placed land on Galatura Estate at the disposal of the Institute for pruning experiments and the facilities afforded in this connection by Messrs. James Finlay & Co., Ltd. and Mr. J. D. Hoare, Superintendent, Galatura Estate, are gratefully acknowledged. Messrs. George Steuart & Co., have again afforded accommodation for some of the Nettle Grub Staff on Gonakelle Estate. The Superintendent, the Colombo Observatory, has continued the loan of meteorological instruments and Mr. F. J. Whitehead has once more given invaluable help in many engineering problems.

Messrs. Forbes & Walker, Messrs. Lee, Hedges & Co., Ltd., Messrs. Mackwoods Ltd., Messrs. Colombo Commercial Co., Ltd. and Messrs. Gordon Frazer & Co., Ltd., have all kindly examined large numbers of experimental tea samples and the assistance so given has been very keenly appreciated.

The Reports of the Scientific Officers are appended.

ROLAND V. NORRIS,
Director.

REPORT OF THE MYCOLOGIST.

Staff:—No changes have taken place during the year. The Mycologist was on leave from July 23rd till October 23rd, during which time the work of the division was under the charge of Mr. F. R. Tubbs, the Plant Physiologist.

Conference:—At the official opening of the Laboratories on February 25th, demonstrations of the methods of investigations used in this division were given and exhibits of the principal fungus diseases of tea were shown. At the Conference which followed, a paper on "The Pruning of Tea in Relation to Disease" was read.

Advisory:—Diseases have not been more prevalent than usual this year, yet there has been a marked increase in the number of enquiries from estates and in the number of specimens submitted for examination. 424 letters were received and 388 despatched. 193 consignments of diseased plants (being an increase of 43 over last year) were received for examination and report; of these 163 were tea and the remainder consisted of miscellaneous green manure plants and shade trees grown on estates.

Visits have been made for investigational purposes to 23 estates in the Balangoda, Bandarawela, Dickoya, Dimbula, Hatton, Hewaheta, Kadugannawa, Lindula, Maskeliya, Nanu-Oya, Norwood, Pelmadulla, and Ratnapura districts.

There have been no new diseases of tea recorded during the year, nor have there been any severe outbreaks of any known diseases.

Poria Root Disease:—The root disease caused by *Poria hypolateritia* continues to be the most prevalent root disease Up-country. This is partly due to the difficulty in eradicating the fungus from the soil of infected areas. It is usually the first root disease to make its appearance in a jungle clearing and unless energetic measures are taken to eradicate the disease before the fields come into bearing, its eradication becomes more difficult, owing to the extended root systems of the bushes.

Although a tea bush appears to die rapidly as a result of this disease, it is still not generally recognised that months usually elapse between first infection and the death of the bush, although no above-ground symptom that anything is amiss is exhibited. During that time the fungus has been able to reach the next bush and consequently it is always ahead of the dead bush. The removal of dead bushes alone can never eradicate the disease.

Consequent to a recommendation that good results have been obtained by the use of iron (Ferrous) sulphate in controlling root diseases of tea, experiments were carried out in the laboratory to test its efficacy against *Poria hypolateritia*. The fungus was grown in petri dishes on a culture medium containing a solution of ferrous sulphate. The fungus was able to grow on a medium containing amounts of ferrous sulphate equivalent to 2½ tons per acre incorporated to a depth of 9 inches. The results of this experiment do not indicate that this substance is likely to prove efficacious in inhibiting the growth of this fungus.

Bitten off Disease:—Further investigations on the "Bitten off" disease of tea seedlings have shown that this condition is usually associated with a neutral or alkaline condition of the soil. It most frequently occurs in nurseries made on the sites of old cooly gardens. Where it is proposed to establish tea nurseries on such sites it is advisable to have the reaction of the soil tested for suitability for tea before proceeding with the work. An unsuitable soil acidity will invariably result in a failure of the nursery.

The importance of suitable soil reaction for tea is not confined to nurseries though it is there that the "Bitten off" disease has been mainly observed. Investigations by the Agricultural Chemist, as a result of an estate sending plants with "Bitten off" symptoms from the field, disclosed the fact that the soil of the whole estate had a pronounced alkalinity owing to its proximity to a limestone belt. His investigations have confirmed the findings of this division concerning the detrimental effects of alkaline soils on the tea plant.

Witches Broom Disease:—Little progress has been made in elucidating the cause of the "Witches Broom" disease of tea. Attempts to induce the disease in healthy plants by grafting, and by pruning them with a knife previously used to prune diseased bushes have proved unsuccessful.

It seems probable that symptoms of the "Witches Broom" disease may result from any cause which interferes with the normal nutritional processes of the bush. Some of the above-ground symptoms of the "Bitten off" disease resulting from alkaline soil conditions resemble closely those of witches broom, and in some cases unsuitable soil reaction may be a contributing factor in the causation of the latter disease. The disease, however, also occurs in soils of suitable reaction.

Recently a bush was observed to be attacked by the Poria root disease and which showed characteristic symptoms of the "Witches Broom" disease. Such symptoms are very unusual where an active parasite is involved; but in this case, owing to climatic or other conditions, the active parasite had progressed very slowly but had sufficiently interfered with the normal activities of the roots without entirely killing them, that above-ground symptoms had been allowed to develop. Bushes in the vicinity showed no "Witches Broom" symptoms. It is unusual, however, to find any parasitic organism on the roots of "Witches Broom" bushes. These usually appear healthy though deficient of smaller feeding roots.

Viewed from this aspect it would appear that a deficiency of an essential nutrient substance (usually other than nitrogen, phosphoric acid and potash), or the presence in minute quantities of some substance toxic to tea, or even any unsuitable mechanical or physical properties of the soil may lead to symptoms similar to those of "Witches Broom". This might account for some of the difficulties experienced in the investigations concerning the causation of this disease, viz. that although the symptoms are similar, the causation may be different in different cases. Whether this be true or not, the investigations of this division indicate that the cause is not a parasitic organism and the disease cannot readily be transmitted as would be the case were it a virus.

Lightning:—Several cases have been investigated in which small areas of tea have suddenly died in such a manner as to give the appearance of a root disease. At first a few bushes wilt and die. Similar symptoms occur later in the surrounding bushes as though an infectious disease were spreading rapidly and centrifugally until as many as a hundred bushes may be involved. After a few weeks the spread ceases and no further losses occur. Where isolation trenches, well sited for the known root diseases, are constructed as soon as the trouble is observed, they frequently fail to arrest the spread of the disease and bushes die outside the isolated area.

No external fungus is to be found on the roots. When examined as soon as the wilting is observed, the cortex of the roots appears to be healthy except for long narrow streaks and small circles dark-brown or chocolate in colour with sharp definite boundaries. The discolouration frequently extends to the wood and in some cases the wood itself is discoloured to a depth of one or two millimetres. Cultures made from the dead tissues under aseptic conditions have given rise to growths of fungi mainly of the Penicillium type usually found in soil. Cultures from apparently healthy tissue adjoining the discoloured areas have remained sterile.

The absence of definite parasitic organisms in the roots and the localisation of the affected areas in the fields support the view that the trouble is entirely of physiological origin. Lightning has been suspected to be the cause but in the absence of direct evidence of a lightning strike the matter was left in some doubt.

Investigations in a few cases where there has been direct evidence of a lightning strike have shown that the affected area exhibits symptoms similar to those described above, including the presence of peculiar streaks and circles of discoloured cortex on the roots. Above-ground injury, such as scorching or cracking of the stems, has been observed in only one case and then a tea bush was completely uprooted. But in all cases examined a number of bushes have died as a consequence, those on the perimeter of the affected area at a later date than those near the centre.

Where young shade trees are interplanted with the tea the affected area may be greater as measured by the shade trees than by the tea. In one instance about 30 tea bushes in a patch were killed as a result of a lightning strike. The effect on young Grevilleas interplanted with tea was noted to extend for a distance of about 100 yards from the affected tea. The Grevilleas near to the struck area died, those further away died back from the top as though affected by a stem "die back", those furthest from the strike being least affected. The symptoms developed much later on the Grevilleas, and the affected area continued to extend for some weeks after its effect on the tea had died out. As the centre of the area of affected Grevilleas coincided with that of the affected tea and as there was definite evidence of a lightning strike at the centre, there can be no doubt that the deaths and die back of the Grevillea were a result of lightning.

Crotalaria Leaf Disease:—Several cases of the leaf disease of Crotalarias caused by *Parodiella grammodes* have been reported during the year. Observations in the field indicate that some plants are highly susceptible, while others are immune, as severely infected plants were

found in contact with, or in close proximity to, others entirely free from the disease. Affected plants are best uprooted and burnt. If allowed to stand they are a source of infection for other plants and in the end afford little material for mulch. Seed should not be collected from diseased plants.

Galls on Gum Plants:—Woody galls resembling crown galls of the apple and other trees were found on the roots, near ground level, of gums grown in a nursery. Attempts to isolate the crown gall bacterium proved unsuccessful. The true cause of these galls was not ascertained. It is, however, inadvisable to plant out such galled plants. They are best destroyed by fire.

Nodule Bacteria:—It has been known for a long time that leguminous plants enrich the soil; for this reason cover crops and green manure plants are usually selected from this class of plants. The efficiency of such plants in enriching the soil is dependent on the presence of bacterial nodules on their roots. The fixation of atmospheric nitrogen is carried out by the bacteria within the nodule and it follows that a leguminous plant without root nodules is no more efficacious in enriching the soil than is a non-leguminous plant.

The nodule organisms isolated from various hosts show certain differences in morphological and physiological characters. They may be separated into distinct groups each of which is capable of producing nodules on a limited number of host plants. Researches elsewhere have shown that there are 12 such distinct groups. If any particular leguminous plant is to be grown successfully the appropriate nodule-forming organism must be present. Little is known concerning the nodule-forming organisms in Ceylon soils or of what plants each is capable of inoculating.

A start has been made in the isolation of the bacteria from a number of plants grown for green manure on tea estates and cross inoculation experiments to determine which plants may be inoculated by the same organism. Where a green manure crop has been grown successfully it should be posible, when this work is complete, to state what other leguminous crops might be grown on the site with equal chance of success. Where the soil is deficient of the requisite nodule-forming organism, it may prove possible to inoculate the seed before sowing with as good prospect of success as has been achieved with lucerne in temperate climates.

C. H. GADD,
Mycologist.

REPORT OF THE ENTOMOLOGIST.

Staff:—Messrs. W. T. Fonseka and K. H. M. Goonatillake were taken on the strength in May, and were stationed at Passara to assist in the Nettle Grub investigation.

Mr. Douglas Austin, in charge of the Nettle Grub investigation in Uva, was taken on to the permanent establishment in October.

Conference:—The new laboratories were opened at the end of February, and various pests of tea and green manures were exhibited in the entomological section. On the day following, a paper was read on the "Control of Insect Pests".

Advisory:—A large number of specimens were received for examination and report. Nettle Grubs were much the most numerous.

General:—1931 marks the first year of work in the new laboratories at St. Coombs. Such a circumstance cannot but involve delays of one kind or another, and there was no exception in this case. In particular, the breeding of the Tortrix parasite was closed down at the end of 1930 at Maskeliya, and it was not until July that the new breeding laboratory was ready, when the work was begun *de novo*.

During the year, the accommodation for the sub-station at Passara was increased, a bungalow being rented for the purpose of a laboratory, and also as quarters for one of the assistants. A portable outside insectary was erected, and some instruments were kindly loaned by the Colombo Observatory for recording temperatures, rainfall, sunshine and wind.

Tortrix:—The problem of breeding eggs for the parasite received a setback when the moth used in 1930, *Ephestia cautella*, refused to develop as it had done before. Its cousin, *E. kuehniella*, behaved likewise; this was sent out from England for trial. It is there bred in rolled oats, but the price in Ceylon renders this prohibitive. However, some measure of success has been achieved with *Corcyra cephalonica*, reared on maize, which refused to breed in 1930.

Trichogramma:—The Tortrix egg parasite was frequently met with in the field, occurring in up to 6% of egg-masses. It is hoped to get a stock of *T. minutum* early in 1932 for trial. This is used in various parts of America and the West Indies on work against various pests. It is smaller in size than the local species, *T. erosicornis*, and offers slightly greater facilities for breeding on this account. The accumulation of a large number of parasites depends on adequate cold storage arrangements. For this purpose, an electric refrigerator was installed at the beginning of the year, but it repeatedly broke down, and large numbers of eggs and parasites died as a consequence. It was replaced by another in June, which, to date, has functioned perfectly well, and has maintained a temperature of 39° ± 1°F. for several months.

Biological Control:—It would appear that parasites may be the only effective means of controlling both Tortrix and Nettle Grub. For this purpose as many different kinds as possible should be introduced from outside. The Empire Marketing Board had intended to appoint an Entomologist to study the question from a general point of view in the East Indies

and Ceylon, amongst other places, and so it was hoped to open up this question with regard to our own particular pests. However, on account of the economic situation, the Board has had its funds considerably pruned, one of the effects of which is that the proposed parasite survey is indefinitely postponed.

Nettle Grubs:—Although the value of reports on the presence or absence of Nettle Grub from estates in Uva had been stressed, they were very hard to get, and it was therefore decided to supply all estates with printed cards to fill up monthly for return to the Passara sub-station, so that we might get some idea of the distribution of the different species, and the rise and fall of attacks. In spite of this, the response, though considerably improved, is hardly commensurate with the great interest which has appeared to be taken in the Uva district. The following table gives the number of returns sent in for the five months, August to December inclusive :—

	No. of Estates
Returns sent in every month	34
Returns sent four months out of five ...	25
,, ,, three months out of five ...	14
,, ,, two months out of five ...	12
,, ,, one month out of five ...	10
No returns sent in	31
Number of Estates to which cards were sent ...	126

Advisory Work:—This includes correspondence, reports on specimens and collections sent for identification or examination; visits to estates; demonstrations on spraying; supervision of spraying campaigns; advice to visitors.

There were many requests for information regarding the life-histories, identification, and parasites of nettle grubs, and measures for their control. A good number of letters despatched have therefore been rather lengthy reports giving in detail all the information desired. This has been greatly appreciated.

A perusal of the summaries given below indicate the expansion of the investigation and the interest shown by the planting community.

	1930	1931
Collections received for examination ...	35	224
Letters received ...	168	404
Letters despatched ...	188	482
Visits to Estates ...	1	30
Field Inspections ...	100	187
Days out spraying ...	48	46
Visitors to Laboratory ...	39	68

Table I gives a summary of the nettle grub returns received in 1931.

NETTLE GRUBS IN 1931.

Nettle grubs were present in Uva all the year round. A census of reported outbreaks showed that the pest was worst and attacked the largest number of estates from May to August, *vide* Table I.

A chart prepared from a census of reports for the whole Island, received between 1897 and 1930, indicated that the worst outbreaks occurred in May, August and October (*Tea Quarterly*, IV, 82).

TABLE I.

Nettle Grub Returns, 1931.

(Figures in first four horizontal columns refer to the number of estates which sent in returns)

	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Reported no attack ...	65	61	52	54	45	40	41	91	100	100	93	83
do Mild do ...	4	8	11	10	18	25	27	27	16	12	13	11
do Medium do ...	2	1	3	2	4	6	5	7	5	2	1	1
do Severe do ...	1	2	5	6	7	1	—	1	2	3	—	—
Total number of Estates attacked ...	7	11	19	18	29	32	32	35	23	17	14	12
Approximate acreage affected ...	840	1126	1980	2123	2422	2077	1916	1380	1126	907	539	423

Table I shows the approximate acreages reported as attacked by nettle grubs in 1931 in the Central Province and Uva. It will be seen that though the largest number of estates to report the presence of the pest was in August, yet the largest acreage attacked was in May. This is because nettle grubs were worst in Passara during the earlier part of the year and attacked a larger acreage of tea than in the Badulla district.

Bionomics:—*Natada nararia* Mo., the fringed nettle grub, continued to be the most widely-distributed species and the one which caused most damage during the year. Specimens for identification and report were received on 81 occasions from 8 planting districts distributed between the Uva and Central Provinces.

Its life-history is as follows :—

Largest number of eggs deposited by one moth was 585. Incubation period ranges from 5 to 8 days with an everage of 6 days.

Larval period or grub stage extends from 29 to 42 days with an average of 36 days.

Pupal period or cocoon stage lasts from 18 to 22 days with an average of 21 days. Longevity of both sexes 12 days.

Chief natural enemies are :—*Fornicia ceylonica; Rhogas* sp.; an Ichneumon, and a Tachinid fly which emerges from the cocoons; *Canthecona robusta,* a predaceous Pentatomid bug; and "Wilt" disease.

Thosea cervina Mo., the "Assam Nettle Grub", comes next in importance. During the year under review it was reported 73 times from six planting districts. Occasionally it is reported as the only species present and responsible for damage. Otherwise it is associated with *Natada* and the other species.

Life-history is as follows :—

Larval stage lasts 45 to 66 days,
Pupal period lasts 35 to 47 days,
Adult period of male and female moths 10 and 12 days respectively.
Chief natural enemies :—*Rhogas* sp., *Apanteles, Fornicia ceylonica, Eurigaster setosa* (Tachinid) and "Wilt" disease.

Thosea recta Hmpn., the "Morawak Korale Nettle Grub". In recent years this species has never been recorded by itself but has always been found associated with *T. cervina.* Under insectary conditions it is observed to be more susceptible to wilt than *T. cervina.* Last year it was recorded 36 times from 4 planting districts limited to Uva.

Life-history :—

Larval and pupal stages last 49-56, and 30-33 days, respectively : Female and male moths live a maximum of 9 and 6 days, respectively.

Chief natural enemies :—*Rhogas* sp., *Apanteles* sp., *Fornicia ceylonica.* and "Wilt" disease.

Parasa lepida Cram., the "Blue striped Nettle Grub", was reported to be causing considerable damage on all the 19 occasions it was reported from both Uva and the Central Province. Its life-cycle is rather long and is being worked out. Largest number of eggs laid by a moth—550. Egg, pupal, and adult stages last 10-15, 43-73, and 6-8, days respectively.

Chief natural enemies :—*Apanteles* sp., (*Parasae?*) *Eurigaster setosa* (*Tachinidae*), and Wilt. In the insectary Wilt was responsible for a mortality of over 75 per cent when the grubs were less than three weeks old.

Scopelodes venosa Wlk., the "Large Nettle Grub", was first recorded in 1903 on tea near Peradeniya. In December 1930 it appeared in Passara. During 1931 it was recorded on four occasions from Badulla and once from Passara. Its life-history is being worked out. Its pupal period as recorded by Mr. Byde Martin of El Teb lasted 155 days. No parasites have been recorded so far.

Spatulicraspeda castaneiceps Hmpn., the "Red banded Nettle Grub", is one of the spineless species, and always found in association with *Natada*. Last year it was reported 19 times from 3 planting districts in Uva.

Life-history :—

> Largest number of eggs deposited by a female moth 265, egg stage 6-8 days, larval stage 39-61 days, pupal stage 15-33 days, and adult stage 6-11 days. From egg to adult 66 to 113 days.

Chief natural enemies :—A Tachinid fly which emerges from the cocoon and Wilt.

Narosa conspersa Wlk., the "Green Gelatine Grub", was reported 37 times from 5 planting districts.

Life-history :—

> Maximum number of eggs deposited by a female moth 235; egg stage 5-8 days, larval period 33-41 days, pupal period 19-26 days. Male and female moths lived a maximum of 7 and 8 days respectively. Egg to adult 63 to 83 days.

Chief natural enemies :—*Rhogas* sp, Tachinid fly from cocoon, and Wilt.

Belippa laleana Mo. "Gelatine Grub.". Since Speyer (Govt. Entomologist) recorded *Belippa* in 1917 as a pest of tea, its presence again does not appear to have been observed till 1931 when specimens were received from Madulsima in July and October. Specimens were also observed among nettle grubs collected from three estates round Badulla in September, October and November. Its life-cycle must be rather long because no moths have as yet (January 15, 1932) emerged from grubs which pupated towards the end of September. No parasites have been observed. Table 2 gives a summary of the life-histories. Table 3 gives a summary of the Distribution of Nettle Grubs in 1931.

TABLE II.

	Natada nararia	Thosea cervina	Thosea recta	Parasa lepida	Scopelodes venosa	Spatulicraspeda castaneiceps	Narosa conspersa	Belippa laleana
Largest number of eggs laid by a Moth ...	585			550		265	235	
Egg stage in days ...	5-8			10-15		6-8	5-8	
Larval or grub stage, days ...	29-42	45-66	49-56			39-61	33-41	
Pupal or cocoon stage, days ...	18-22	35-47	30-35	43-73	155	15-33	19-26	
Adult stage, days ...	6-12	8-12	6-9	6-8		6-11	6-8	
Egg to adult, days ...	58-84					66·113	63-83	
Number of occasions it was reported in 1931 ...	81	73	36	19	5	19	37	5
Chief natural enemies ...	*Fornicia ceylonica*, *Rhogas* Tachinids, *Canthecona robusta*.	*Apanteles*, *Rhogas*, *Fornicia ceylonica*, *Eurigaster setosa*.	*Apanteles*, *Rhogas*, *Fornicia ceylonica*, Tachinids.	*Apanteles*, *Eurigaster setosa*			*Rhogas* Tachinids	
	Wilt	Wilt	Wilt	Wilt		Wilt	Wilt	

TABLE III.

Summary of Distribution of Nettle Grubs in 1931.

(Figures relate to number of estates from which Nettle Grubs were collected and sent to the Laboratory for identification.)

Planting District	Natada nararia	Thosea cervina	Thosea recta	Parasa lepida	Narosa conspersa	Spatulicraspeda castaneiceps	Belippa laleana	Scopelodes venosa
Badulla District	38	25	11	6	10	4	3	4
Dimbula ,,	1	—	—	—	—	—	—	—
Haputale ,,	3	15	6	2	6	—	—	—
Kelebokka ,,	1	3	—	—	—	—	—	—
Madulsima ,,	8	7	3	1	4	2	2	—
Passara ,,	28	22	16	9	16	13	—	1
Pussellawa ,,	1	—	—	1	—	—	—	—
Uda-Pussellawa	1	1	—	—	—	—	—	—
Total number of Collections	81	73	36	19	37	19	5	5

NATURAL CONTROL.

Parasites. Hymenoptera :—*Apanteles* sp, *Rhogas* sp, and *Fornicia ceylonica* appeared during the year but were most plentiful from June to August. They were present in all the planting districts in Uva, while *Fornicia ceylonica* was observed to occur in Dimbula and Uda-Pussellawa as well.

Several minutes unidentified hymenopterons were observed to parasitise both species of *Thosea, Natada,* and *Narosa* in their very young stages. An unidentified Ichneumon was bred from the cocoons of *Natada.*

Diptera.—Tachinid flies occasionally emerge from the cocoons of *Natada, Thosea,* spp., and *Parasa.* Those which emerged from the last two mentioned hosts were identified by the Imperial Institute of Entomology as *Eurigaster setosa,* Dol.

Attempts to find alternate hosts for *Apanteles, Rhogas* and *Fornicia* have not been successful. The suggestion made in the report for 1930, p. 17, that "if any good results are to be obtained by means of parasitic control, the parasites to be employed will have to be found outside the Island, possibly in Malaya or the Pacific Islands" will require further attention if an attempt is to be made to tackle the nettle grub by biological methods.

Predators :—The predaceous pentatomid bug *Canthecona robusta* Dist., was very much in evidence in Passara from February to May, and in June near Bandarawela.

In the tea both adults and nymphs have always been observed preying on *Natada.*

Eggs, which are bronze coloured, are laid on leaves and hatch within 8 to 13 days. The nymphs are bright red in colour and moult five times during a nymphal period ranging from 23 to 28 days. Adults are dark-brown in appearance—the female is slightly larger than the male—and have lived for three weeks.

A similar bug *Cantheconidea furcellata* Wolff, is recorded from Java as a natural enemy of the nettle grub *Setora nitens* Wlk., and other caterpillars feeding on tea.

It was suggested during the year that the Red ant (*Oecophylla smaragdina* Fb.), should be utilized to eradicate nettle grubs from the field. According to Tennent and other writers this insectivorous ant was employed to check the ravages of the Coffee bug (*Coccus viridis,* Green) when it was devastating the coffee plantations.

With reference to nettle grubs it is not quite clear, if indeed they do so, whether these ants attack the pest in the grub stage or the moth stage. In Passara when liberated on the tea they did not attack the grubs.

A small species of red ant (not identified as yet) was observed to feed on the eggs of *Parasa lepida* when laid in cages in the insectary.

Wilt:—Wilt was in evidence in Uva throughout the year and it is quite probable that it contributed towards the disappearance of *Natada* from several estates. Hitherto Wilt has mainly been an effective controlling agent when nettle grubs were pactically full grown. In 1931 two remarkable instances occurred when Wilt was mainly responsible for the complete extermination of the pest (*Natada*) before the grubs were 2 to 3 weeks old and hardly capable of any defoliation. The first instance was in June in Passara, the second in October in Madulsima. The spraying of Wilt in the field was attempted in June on an estate which was attacked by *Natada*. A preliminary examination showed that very little Wilt, if any at all, was present. Wilted grubs were collected from another estate a couple of miles away and a decoction made by macerating the grubs in water. The proportion was approximately 5 grubs to a gallon of water. Spraying was carried out every morning for a week with the ordinary 2-gallon pneumatic knapsack sprayers. The field selected for the experiment was in a depression and one not too exposed to wind. A week to ten days later examinations of the unsprayed fields showed that Wilt was present and 10 per cent of the grubs were affected, while in the sprayed area the percentage of those killed by Wilt was 40 on the average.

Control Measures:—The following insecticides were tested during the year.

Sprays:—Pyrethrum emulsion, Tephrosia decoction, Uno, soft soap, laundry soap, lead arsenate.

Dusts:—Pysect, nicotine, Polvo, Derrimac.

Uno and Pysect are pyrethrum products, whilst Polvo and Derrimac are manufactured from Derris.

Dusting, in general, was not so successful as spraying. The chief drawback was the inability to make the dusts adhere to the undersides of the leaves. Polvo was the most effective and gave a 75 per cent kill.

Spraying:—Of all the above-mentioned sprays, laundry soap (the Umbrella brand) when diluted in the proportion of 1 lb. soap in 30 to 35 gallons water was found to be the cheapest and most effective.

Two groups in Passara adopted this spray and were quite satisfied with the results. The approximate cost of spraying an acre is Rs. 15/-, provided too much labour is not required for the transport of water.

McDougall's super-arsenate of lead, priced at Rs. 2/- a lb., is recommended for the spraying of tea nurseries and new clearings when attacked by nettle grubs. A pound in 30 gallons water is the proportion suggested, and 2½ lbs. should be sufficient to spray an acre. It would take 2 coolies 3 days to spray an acre with one spraying machine.

It has recently been recommended that (a) Collections of grubs and cocoons made during the months of June, July and August, when Parasites are plentiful, should not be destroyed but placed in large cages or boxes covered with galvanized wire mesh which would allow only the parasites to escape and carry on their useful work in the field. This measure is

suggested in order to conserve the parasites already present on an estate. (b) Should it be necessary to prune a field very badly attacked, all prunings should be burnt if the grubs are more than half-grown. If less than half-grown the prunings can safely be buried without any fear of the grub making cocoons. More detailed notes on spraying, dusting, and other measures of control will be found in Part III of the article on Nettle Grubs by Mr. Austin, now appearing in *The Tea Quarterly*.

Acknowledgments:—The thanks of the investigators are due to the following for all the assistance so readily given during the year by supplying labour, specimens, etc., for experiments, and in many other ways co-operating with the Passara staff:—

Messrs. Rennie & Brown of Gonakelle,
Mr. Newland of Blarneywatte,
,, Metcalfe of Passara Group,
,, McMurray of Ury,
,, Sentence Smith of Telbedde,
,, Reid of Demodera Group,
,, Byde Martin of El Teb.

Mites:—As usual, Mite infections became prevalent in March and October. Yellow Mite, *Tarsonemus translucens*, was occasionally abundant in the Ratnapura district in October, although there had been about four months without sun, and with a heavy rainfall. Mites are usually considered dry weather pests, but it seems that if the plant is subjected to adverse weather conditions, such as absence of sunshine, Yellow Mite, at least, can thrive and inflict on the plant considerable damage. Assuming that absence of sunshine was the principal cause of the attack, and further assuming that fine periods would not long be delayed at that time, it was suggested that the tea should be left alone to see what effect sunshine would bring. The fine weather was not long in coming, and was followed by renewed growth on the part of the bushes, and the Yellow Mite quickly disappeared. One report was received of the Purple Mite (*Eriophyes carinatus*) under similar conditions.

C. B. REDMAN KING,

Entomologist.

REPORT OF THE PLANT PHYSIOLOGIST.

Correspondence:—The amount of correspondence dealt with has increased considerably during the year, 290 letters being received and 332 being despatched, as compared to 88 and 101 respectively in nine months of 1930.

Visits:—The number of estates visited during the year was eighteen, a total of twenty-four visits being made.

Acting:—The Plant Physiologist acted for the Mycologist from July 22nd to October 22nd., and has been in charge of the Agricultural Chemist's field experiments since that Officer's departure on leave on December 16th., in addition to his departmental duties in both cases.

Staff:—Mr. D. J. Welaratne resigned his position as laboratory assistant on September 1st, and Mr. M. H. E. Koch has been appointed to the vacant post. Mr. D. Nicol joined as field assistant in August.

Seedling Experiment:—An experiment to determine the effect of the removal of the seed-shell upon the germination of tea seed was terminated during the year, and will be more fully reported in *The Tea Quarterly*. The results show that as the plants increase in size the advantage gained from shelling the seed becomes less evident, and it appears that the enhanced cost of treatment and the greater liability to injury by unfavourable weather conditions is unlikely to be compensated for by the increased size of the seedling.

Cracking the seed as advocated by Gadd [1] and Shaw [2] obviates the disadvantages associated with complete removal of the seed-shell.

Age of Stumps:—An enquiry was received during the year relative to the age of certain tea stumps. The estimation of the age of temperate plants is rendered possible by the regular succession of active and dormant periods, the transition from one to the other in spring and autumn being accompanied by changes in the size and structure of the wood vessels which result in the production of "annual rings". Their formation may be complicated by the production of additional rings due to insect attack or unusual weather conditions. In Ceylon, conditions are such that several cycles of growth may occur in a year, each being marked by a more or less definite growth ring. It is, therefore, impossible to interpret them without a knowledge of the factors affecting the growth periodicity of the tree during its life. It is not, therefore, at present possible to estimate the age of plants with any accuracy by inspection of the growth rings.

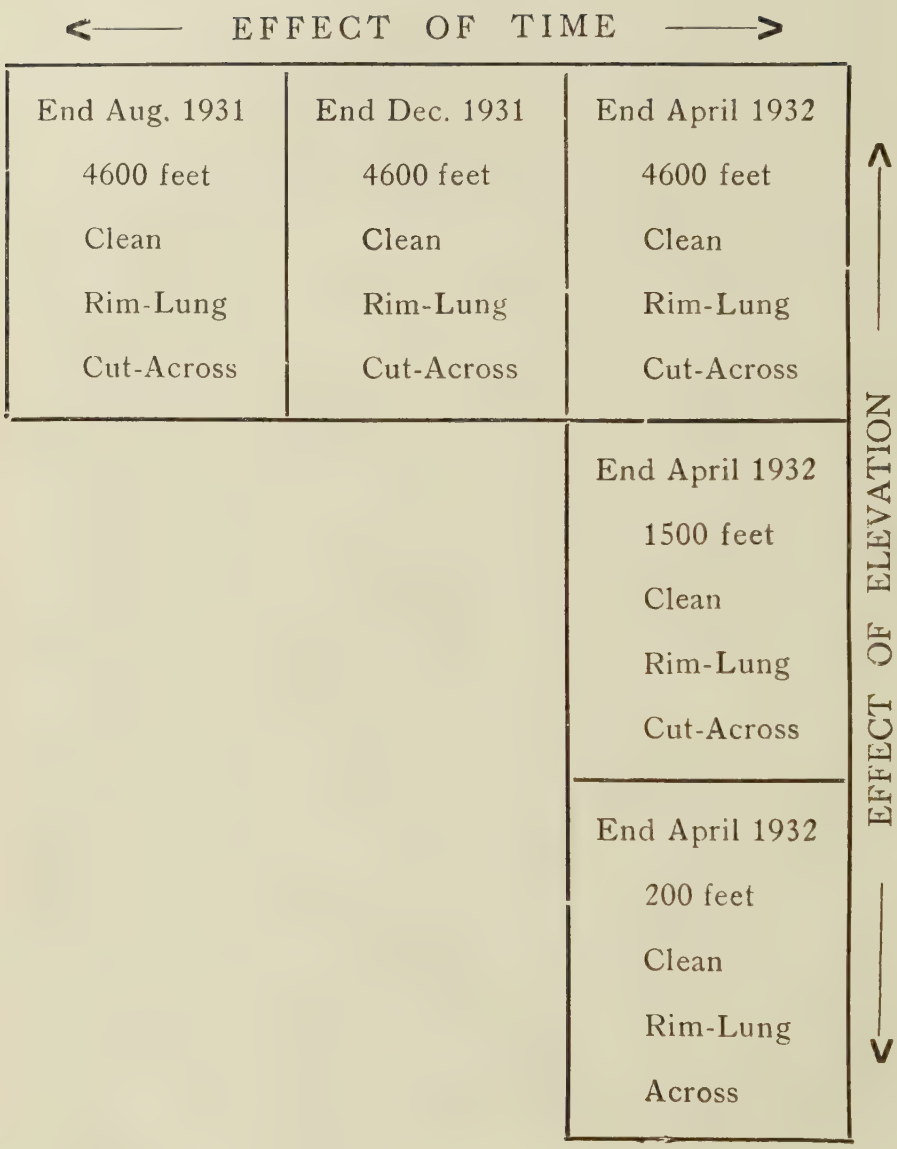
Stumping Experiment:—The results of the transplanting experiment reported last year suggested that an examination was required of the various methods of planting tea seedlings that have been reported from time to time. It was found possible to superimpose such an experiment upon the patna opening and drainage experiment initiated by the Agricultural Chemist. Five different treatments of two-year-old seedlings grown from Cranleigh seed are being tested, namely:—

(a) Planted intact as lifted from the nursery.
(b) All leaves and green wood removed, roots untouched.
(c) As (b), with all lateral roots removed.
(d) Stumped to six inches, roots untouched.
(e) As (d), with all lateral roots removed.

Data are being collected on the growth and establishment of these plants, from which it will be possible to decide upon the relative merits of the treatments for the establishment of plants on a clearing. In addition the estimation, in conjunction with the Agricultural Chemist, of the effect of the cultural treatments upon the growth and, later, yield of the plants is rendered possible by a random arrangement of the stumping treatments upon the cultural plots.

Pruning Experiments:—A commencement has been made during the year upon the examination of the pruning systems applicable to tea and the factors affecting them. Experiments have been set out whose design allows of the collection of data from which the effects of type of pruning, of time of pruning, and of elevation may be gauged. Three types of pruning are being used, namely, clean pruning, rim-lung pruning, and cut-across pruning, all at a height of three inches above the previous pruning level. Each of these three *types* is being performed at St. Coombs at each of three *times*, the end of August 1931, December 1931, and April 1932. The nine treatments thus obtained are being tested on six blocks of nine plots each. The size of each plot is two hundred and fifty bushes. By this arrangement each of the fifty-four plots contributes to the estimation of the effects of both time and type of pruning.

The examination of the effects of those climatic factors bound up with elevation is rendered possible by the establishment of experiments at the Government Experiment Station, Peradeniya, at an elevation of 1,500 ft. and at Galatura Estate, Kiriella, at about 200 feet above sea level. These are only rendered possible by the co-operation of the Director of Agriculture and his officers and of Messrs. James Finlay & Co., Ltd., and the Amalgamated Tea Estates Co., Ltd., respectively. At these two centres, eighteen plots of equal size to those at St. Coombs will be started simultaneously with the April portion of the St. Coombs experiment, the same three types of pruning being used. The relation of the experiments at St. Coombs, Peradeniya and Galatura to each other is indicated by the diagram.


EFFECT OF TIME
End Aug. 1931
4600 feet
Clean
Rim-Lung
Cut-Across
End Dec. 1931
4600 feet
Clean
Rim-Lung
Cut-Across
End April 1932
4600 feet
Clean
Rim-Lung
Cut-Across
End April 1932
1500 feet
Clean
Rim-Lung
Cut-Across
End April 1932
200 feet
Clean
Rim-Lung
Across
EFFECT OF ELEVATION

Records will be kept of yield, and of the amount of banjhi removed. In addition, the effect of pruning upon the tannin content of the leaf will be examined at St. Coombs and its effect upon quality will be examined by the Biochemist by the manufacture of leaf from different treatments separately.

The evaluation of the interactions between the factors being experimented with in their effect upon yield will be rendered possible by these experiments in addition to that of the direct results of each factor. For example, while the comparison of one method of pruning to another at the same elevation and of the effects attributable to varying elevation is of interest, the examination of the interaction between the two factors, pruning and elevation will show whether the effect of a method of pruning at one elevation is different to its effect at another.

The period between pruning and tipping is of considerable interest inas-much as the first indications will be found there of those differences in growth which will later be recorded in the plucking basket. Growth records are, therefore, being kept during these periods.

In order that no disturbing effects may be introduced by variations in the manuring from time to time or place to place, the following amounts of nitrogen, phosphate, and potash are being applied per thousand bushes in one pruning cycle.

N_2	P_2O_5	K_2O
40 lb.	40 lb.	30 lb.

The manures used are blood meal, ordinary superphosphate, and muriate of potash. The manure is applied at eight-month intervals and thus in a thirty-two-month cycle at St. Coombs four applications of 10, 10, and 7½ lbs. will be made, while, in the two-year cycles at Peradeniya and Galatura three applications of 13⅓, 13⅓, and 10 lbs. are necessary. In the absence of definite evidence of the best time to apply the manure, the first application is being made just after pruning.

Seed Races:—During the year tea seed samples from twenty-five Ceylon estates have been received, and data collected upon their characteristics and origin. Samples from U.S.S.R. and from Java are also being obtained. The plants resulting will be used for an examination of the growth, form and composition of the different races, whereby an analysis and description of existing varieties will be rendered possible. The experiment is planned to serve two subsidiary purposes in addition, firstly, as a demonstration plot and secondly, as a source of data from which an estimate of the errors associated with the use of plots composed of a single bush may be made.

The importance of this type of experiment is easily realised. Both the field experiments at St. Coombs cover an area of approximately four-and-a-half acres, a size that raises difficulties in the way of further expansion in field work, both in space and labour. There are three methods by which these difficulties may be surmounted. The possibility of intermittent plucking records being used in place of a continuous series has already been examined by the Agricultural Chemist, with promising results. Many problems exist however, which will require detailed observations on individual

bushes for their elucidation. The number of bushes that can be examined in this way is, however, strictly limited by the labour available. For example, the largest number of bushes upon which observations upon recovery from pruning can be made is seven hundred and fifty bushes, and this can only be done up to the stage of the first tipping. With the existing heterogeneity in the tea examined, the error attached to the observations is uncomfortably high even when the maximum number of bushes is used. Attention must therefore be paid to the possibility of reducing this heterogeneity, both by clonal propagation and by yield regressions on single bushes. This experiment will provide additional data for the testing of the latter method. The possibility of clonal work is already the subject of investigation.

Tannin:—Tannin has been found to occur in the leaves and cotyledons of seedlings and in small amount in the stems of mature bushes. The percentage of tannin in the leaves of overgrown flush falls rapidly from the bud to the fourth leaf, after which the fall is more gradual, the absolute amount increasing from the bud to the more mature leaves and then falling.

Preliminary experiments upon the effect of keeping such flush in darkness, or supplying it with a solution of potassium nitrate showed no effect upon the tannin content.

Defoliation:—At the request of the Entomologist an experiment is being carried out to determine what effect defoliation has upon the wood growth and yield of tea bushes. The results to date show that in the first three months after defoliation a highly significant decrease in the yield occurs, a loss that has not been recovered in the four months that have elapsed since defoliation was performed. These conclusions cannot be accepted as final, however, since the bushes were defoliated just after an exceptionally bad south-west monsoon when atmospheric conditions had reduced yield to a minimum. The yield of the control bushes increased steadily for two months after the initiation of the experiment. The experiment is therefore being repeated in 1932.

The resistance of the tea bush to defoliation, provided that it is not allowed to dissipate its reserves by producing leaves which are destroyed soon after formation, is shown by a bush which still continues to push forth buds after being maintained in a leafless condition for the past eighteen months.

Plucking Records:—During the past ten-and-a-half months observations have been made upon the growth of flush upon three bushes. The base of each shoot as plucked was marked with a zinc tag bearing the number of the plucking round, which occurred at regular ten-day intervals. This enabled the estimation of the mean time taken to produce the shoots plucked in any one round, those shoots whose origins were so far from the point of plucking as to render their relation to any particular plucking round uncertain being neglected:

Mean Regeneration Time

Months	April & May	June & July	Aug. & Sept.	Oct. & Nov.
Bush 1	66·3	66·5	86·4	107·7
Bush 2	69·2	65·4	89·0	133·7
Bush 3	64·2	65·9	70·5	100·9

Bushes pruned 19-11-30.

It is at present uncertain whether the increase in regeneration time is a seasonal effect or one due to ageing of the bushes, but continuing the records until May 1932 will enable this point to be determined.

The yield of the bushes has shown a regular succession of maxima and minima, which do not appear to be related to any climatic factors. It is likely that they are the outward expression of a rhythm of growth processes inherent in the constitution of the plant.

No regular trend of the coefficient of variability of shoot number with time from pruning has been found to date.

Bud Break:—No enhanced rate of bud break was observed to result from painting the dormant buds of pruned tea seedlings with sodium thiocyanate or ethylene dichloride.

Layout:—During the south-west monsoon a large programme of ornamental and shade tree planting was undertaken. The grassing down of areas adjacent to laboratories and bungalows has also been proceeded with. *Paspalum dilatatum* has proved very unsatisfactory for this purpose, save for the purpose of supporting banks of spoil earth.

Acknowledgments—are due to the Curator of the Royal Botanic Gardens for the assistance afforded by him, and to the Curator of the Hakgala Botanic Gardens.

REFERENCES

(1) Gadd, C. H. Tea Research Institute, Bulletin No. 3, 1928, p. 16.

(2) Shaw, W. S. U.P.A.S.I. Administrative Report 1927-28, p. 8.

F. R. TUBBS.

Plant Physiologist.

REPORT OF THE AGRICULTURAL CHEMIST.

Staff:—Mr. C. A. de Silva, B.Sc., Agric. (Lond.) C.D.A. (Wye) was appointed Research Assistant in the Department of Agricultural Chemistry during the year, and commenced duties on March 1st. Mr. M. Piyasena commenced duties as Field Assistant on January 1st.

Advisory Work:—23 letters were received, and 141 despatched. An analysis of the subjects of enquiry shows that in reply 39 related to the growth and use of green manures, 30 dealt with fertilisers, and the balance of 72 with miscellaneous soil subjects. The preponderance of letters on green manures is a reflection of the interest that is prevalent in the districts on the subject of soil conservation. Seven visits to six estates were made, the districts being Dimbula, Bandarawela and Balangoda.

Lectures were given as follows:—

"Soil Erosion: the Present Position".—Sabaragamuwa P.A.

"Green Manuring in Relation to Artificial Manuring".—Dolosbage-Kotmale P.A.

Publications:—(a) Studies in the Yield of Tea. 1. The Experimental Errors of Field Experiment with Tea.—*Journal of Agricultural Science* 1931, *Vol. XXI.*

(b) *Tea Research Institute Bulletin No. 6.* (A less technical version of the former publication).

LABORATORY.

Investigations in Connection with Advisory Work:—There has been an increase in the analytical work carried out in the department in connection with enquiries from estates. The department does not undertake the routine analysis of soils and fertilizers, but cases of anomalous soil conditions occur periodically which call for laboratory examination. Analysis in these cases invariably follow personal investigation on the spot, and the collection of samples is always dependent on the ascertained local conditions. Isolated samples when sent in by estates are generally of little or no value.

One of the most interesting investigations of the type here referred to, deals with the subject of soil reaction. Mention has been made of this work in previous annual reports; formerly, cases were restricted to small areas. During the past year, a whole estate has been found to be suffering from pronounced soil alkalinity. This has afforded a unique opportunity of confirming and extending previous observations.

Pathological Symptoms Due to Soil Alkalinity:—The importance of the large-scale occurrence of soil alkalinity lies in the fact that it has allowed of the definition of the pathological symptoms associated with alkalinity with a very considerable degree of certainty. It is now clear that both the above-ground portions of the plant and the roots, show definite and lasting symptoms. As regards signs above ground, the main axis of the plant fails to elongate; the leaf buds are all crowded together, and since most of

the leaves fail to reach maturity, they fall off at an early stage, leaving numerous scars closely packed together. Frequently only the leaves near the growing point are left, and side shoots are totally absent.

The root is equally distinctive. There is in severe cases a complete absence of taproots, the rudimentary organ coming to an abrupt end about an inch below the seed level. These symptoms are usually referred to as "bitten off". Lateral roots are few, and are usually concentrated at the "bitten off" point. They bear little evidence of root hairs and are discoloured and brittle. These symptoms hold good whether the plants are being raised in an alkaline nursery or are older plants transferred from healthy nurseries to an abnormal soil. The damage is thus not confined to nursery sites. Plants as old as four years have been found with precisely these symptoms, and with no indication that they will outgrow the deformity.

GENERAL INVESTIGATIONS.

Artificial Farmyard or Bulk Manure:—The analysis of the Adco heap referred to in the last report have been completed for nitrogen and pentosan contents. Nitrogen analyses furnish a useful indication of the agricultural value of the manure, whilst the behaviour of the pentosans shows how the process of fermentation is proceeding. Table 1 gives the analyses of these constituents and the approximate dry matter content of the heap.

TABLE I.

Analyses of Adco Heap.

	Pentosans %	Nitrogen %.	Dry matter lbs.
Original Material ...	24·0	1·46	450
First Month ...	19·9	1·26	—
Second Month ...	12·2	1·51	—
Third Month ...	10·7	1·73	350
Fourth Month ...	8·0	1·49	—
Fifth Month ...	6·5	1·47	—
Sixth Month ...	4·8	1·47	—
Seventh Month ...	4·1	1·44	—
Eighth Month ...	3·5	1·28	340

Over the experiment as a whole there was a continual loss of dry matter and pentosans. Finally, nearly 90 per cent of the pentosans had been dissipated. During the initial or "manufacturing" stage the loss is rapidly; during the storage stage (the last five months) the loss becomes progressively less.

The changes in nitrogen content are markedly different. Apart from a decrease (which will be referred to later) in the first month there is a progressive increase to a maximum followed by a decline of variable intensity. The low figure for the first sample is explainable as a sampling error. The figure for the original material is calculated from the nitrogen in the *manna* grass plus the added Adco reagent. The reagent is sprinkled on the grass

layer by layer and, until decomposition and mixing is well forward, a heterogeneous mass presents insuperable obstacles to accurate sampling. After the first month these difficulties largely disappeared judging from the figures of the half dozen replicate samples taken on each occasion.

The rise in nitrogen is explained by the fact that when the artificial bulk manure is properly made, the heap loses carbohydrate dry matter, without a corresponding loss of nitrogen. In terms of percentage composition therefore the nitrogen value appears to increase. The heap in question appears to be adequately made. Confirmation is afforded by calculating the total amount of nitrogen in the heap at the beginning and at the maximum point. In the beginning the heap contained 6·59 lbs. of nitrogen from all sources. At the end of three months it contained 6·05 lbs., thus showing a loss of some 8 per cent. During the same period the dry matter of the heap had diminished from 450 to 350 lbs. which represents a loss of 22 per cent. From a practical point of view the loss of 8 per cent of nitrogen may be regarded as not excessive.

The subsequent loss of nitrogen is attributable to loss on storage. Of set purpose no particular precautions were taken in the matter of storage. The main purpose of the experiment, as set out in the previous report, was to separate as far as possible evidence for storage losses as against losses during manufacture.

The decrease in nitrogen content from the maximum is very striking and the approximate dry matter figures show that it is, in the main, a loss without commensurate dry matter loss. When finally the heap samples were discontinued, the heap had lost on storage over 1·5 lb. of nitrogen or some 26 per cent of what it contained at the time of maximum efficiency. It is evident that the whole period divides itself into two sections, one with a loss of dry matter and a little nitrogen loss, and the other where dry matter suffers least and nitrogen most. The results have an interesting bearing on the manufacture of Adco bulk manure under present conditions. They demonstrate that a satisfactory manufacture is possible, but that storage must receive special attention. Unfortunately adequate storage demands conditions radically opposed to those required for active manufacture. The latter depends on adequate aeration, the former on the exclusion of air. It is probable that in practice Adco manure is kept too long after manufacture is complete. The three months required in this instance to attain maximum efficiency is abnormally short, since a thorough turning of the heap was carried out at each sampling and this expedites matters. In practice something less than twice this time should suffice. If the time of completion of manufacture cannot be fitted in with the time of usage, the compacting of the heap, and covering with a layer of soil, after the manner of clamping farmyard manure, is desirable. It should be recognised that the storage loss phenomenon is not peculiar to Adco manure, but is common to all composts of the same type.

FIELD EXPERIMENTS.

Potash and Nitrogen Experiment:—The year under report saw the completion of the first year of the potash and nitrogen experiment outlined in last year's report. For details of the design, reference should be made to that report and to the appendix on page 42 of this report. It was the

aim of the experiment to give information on the effect of single and double doses of potash and nitrogen, the unit dose in each case being 20 lbs. per acre; the experiment also included a comparison of blood meal, cyanamide, and sulphate of ammonia in equivalent doses. Phosphoric acid to the extent of 30 lbs. per acre was supplied as superphosphate to all plots equally.

Table II provides a summary of the results for the year following pruning. The field was very slow in coming away, and consequently only 25 plucking rounds were taken, which accounts for the low yield level. The mean level of crop production corresponds within a few per cent with the corresponding level of the non-experimental portions of the field.

Before discussing the yields, mention may be made of a few points of technical interest. The actual experiment was preceded by a short cropping trial in the last pruning cycle. The results of this trial, which were reported last year, indicated that the error due to plot heterogeneity was uncomfortably large. A reasonable hope was expressed that the trial over a longer period, with more careful attention to pruning and plucking than was possible before the acquisition of the estate, might be expected to reduce this error. The following figures indicates the justification of that hope:—

	Previous cropping.	Present experiment.	Scrubs trial.
Standard error per cent for single plot ...	21·80	8·12	9·90

It will be seen how much lower the error of the present trial is. Expressed in the proper terms, this experiment is seven times as accurate as the previous cropping trial. The details of the experimental technique used were based on the findings of the Scrubs uniformity trial, an account of which has recently been published. The figure in the third column above gives the error found in that trial for a plot of approximately the same size. There is a marked similarity between the two levels of error which shows not only that the results of the Scrubs trial were well founded, but that the usefulness of the Scrubs investigation was beyond cavil.

TABLE II.

	Nitrogen Quantities			Potash Quantities			Nitrogen Type		
	Nil	20 lb. per ac.	40 lb. per ac.	Nil	20 lb. per ac.	40 lb. per ac.	Blood-meal	Cyana-mide	Sul-phate of Am-monia
Yield per acre in lb. dry wt....	501·8	515·7	526 6	517·5	509·1	517·4	522·6	517·9	522 9
Standard Error lb. ...	9·9			9·9			12·1		
Yield per cent of mean ...	97·5	100·2	102·3	100·5	99·0	100·5	100·3	99·4	100·3
Standard Error per cent .	1·9			1.9			2·3		

As seen from Table II, the standard error for the means of treatment in the cases of comparisons between different doses of nitrogen and potash has been reduced below two per cent. The attainment of so high a degree of accuracy gives considerable weight to the agricultural deductions that can be made from a study of the mean yields. It is of particular interest therefore to find that in none of the comparisons set out in Table II do the differences exceed those ascribable to error. The results are set out both in pounds per acre, and in terms of a percentage index based on the general average. The greatest difference between treatments occurs between nil and double nitrogen, amounting to 4·8 per cent. With a mean error of 1·9 per cent, however, a difference of 5·4 per cent is the lowest value for which it would be safe to say that the treatment difference is the assured cause. None of the other differences reach this figure. A sidelight on error is given by the figure for single potash which is less than that for no potash. The effect is entirely one of error and is not due to an inhibitive effect of potash.

On the basis of these results the practical conclusion to be drawn is that the pruning mixture applied at the time of pruning has been ineffective. Whilst it is not justifiable to generalise about this, the fact in the present instance is incontravertible in view of the low error value.

In looking for possible causes, two propositions present themselves for closer investigation.

(a) Is the tea bush for some considerable time after pruning incapable of making efficient use of a pruning mixture; and is recovery chiefly conditioned by the food reserve status of the bush ?

(b) Is the severity of the S.W. Monsoon rainfall in this year a contributory cause to the failure of manurial response ? Possibly both causes contributed if the suggestions are valid. By the time the bush was functioning as a thoroughly efficient assimilative machine from a nutritional point of view, had the wastage of supplies of added nutrients reached such dimensions as to minimise the possibility of response ?

A further point is the virtual equivalence of blood meal, cyanamide and sulphate of ammonia. The "organic" artificial showed no advantage over the inorganic form. According to traditional opinion, one might have expected a smaller wastage from blood meal, with consequent indications of response from this treatment in the later stages of the experiment. The effect if present is too small to be noticeable. The results of the second year may be expected to throw additional light on these matters.

SOIL EROSION.

Drainage and Clearing Experiment:—As a first step towards implementing the promise of the Institute to further the cause of work on soil erosion, a clearing experiment has been commenced this season. A small area, two acres in extent, has been laid out on a steep slope with ordinary, bunded drains, and reverse step drains, there being twelve sections of each type. In addition, the patna land in which these drains were cut has received two different treatments. The thirty-six drains form the boundaries of the thirty-six plots, half of which had the patna plain forked, and half of which

had the patna burned before forking. The plots are grouped together in randomised pairs so that a burned and unburned plot always adjoin.

The plan of campaign which has just been initiated is to measure the run-off into the individual drains at short intervals during heavy rain storms, and to collect samples of the turbid run-off for a comparison of their silt content. A continuous self-recording rain gauge has been installed which permits the measurment of rainfall between any of the intervals between run-off measurements. In this way it will be possible not only to gain knowledge of the effectiveness of the drainage systems, but to compare the behaviour of burned and unburned land in respect of run-off and absorption.

A complementary study is being made of the losses of organic matter and nitrogen due to the differential treatment of the patna. Later on, with the co-operation of the Plant Physiologist, a study of the effect on the growth and yield of the young tea is contemplated.

Cover Crops:—The cover crop demonstration plots have experienced a year of severe trial. In the first place, drought in the early stages militated against good establishment. The crops also suffered from the severity of the S.W. Monsoon. Of the score of species grown the following types only show promise:—

Clitoria cajanifolia	*Calopogonium mucunoides*
Pycnospora hedysaroides	*Puerария phaseoloides*
Atylosia scarabaeoides	*Tephrosia Vogelii*

Tephrosia candida

The rains destroyed all hope of seed supplies for further experiment, consequently the next year's work will have to be restricted to growing species for seed, and thus assuring the continuity of the work.

T. EDEN,
Agricultural Chemist.

APPENDIX

POTASH AND NITROGEN EXPERIMENT

Field No. 3 *First year*

BLOCK A

1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*
487.4 1K	**518.8** 2S 1K	**501.5** 1B 2K	**567.1** 2B	**514.8** 2K	**521.9**	**516.7** 1S	**508.7** 2C 2K	**457.7** 1C 1K

BLOCK B

3	*6*	*9*
505.3 2B 1K	**544.6** 1B	**537.0**
2	*5*	*8*
541.2 1C 2K	**568.6** 2K	**552.1** 1K
1	*4*	*7*
593.8 1S 1K	**550.0** 2C	**592.4** 2S 2K

BLOCK C

3	*6*	*9*
520.8 2C 1K	**554.2** 2S 2K	**439.0** 2K
2	*5*	*8*
473.0 2B	**532.0** 1S 1K	**506.3**
1	*4*	*7*
509.2 1B 2K	**492.1** 1K	**549.6** 1C

BLOCK D

3	*6*	*9*
559.4 1B 1K	**467.3** 1S	**524.2**
2	*5*	*8*
502.9 1C 2K	**507.8** 2K	**521.0** 2B 1K
1	*4*	*7*
499.4 2S	**446.6** 1K	**514.4** 2C 2K

Experimental Design.—Randomised blocks in sixfold replication.

Plot size.—One-twelfth acre.

Manuring.—Basal dressing of Superphosphate 30lb. P_2O_5 per acre.

Nitrogen and Potash.—20 and 40 lb. per acre (Single and Double doses), applied November 26th.—December 3rd, 1930.

Pruning.—Clean pruned November 10-18.

Tipping.—March 18-20; April 14-15; May 5.

Plucking.—Regular 9-day rounds. 25 rounds in the first year.

BLOCK E

3	*6*	*9*
584.2	**562.2** 2B 2K	**620.4** 2C
2	*5*	*8*
564.6 1C	**498.5** 1K	**545.2** 2K
1	*4*	*7*
455.0 1S 2K	**568.0** 2S 1K	**574.3** 1B 1K

BLOCK F

3	*6*	*9*
387.8 1C 1K	**426.7** 2S	**496.1** 2C 1K
2	*5*	*8*
465.6 2K	**474.5** 1B	**550.8** 1S 2K
1	*4*	*7*
388.1	**452.6** 1K	**479.4** 2B 2K

The figures in italics are the plot numbers. Heavy type represents total yield per acre. The signs in the bottom corners represent treatments. The figures stand for single or double doses. The absence of signs indicates that the plot received only the basal phosphate dressing.

The following is a schedule of abbreviations:—

B=Blood Meal 13·8% Nitrogen. C=Cyanamide 19·9% Nitrogen. S=Sulphate of Ammonia 20·9% Nitrogen. K=Muriate of Potash 50·9% K_2O

The Super used gave 18.2% P_2O_5

Summary of Results.

	Nitrogen Quantities			Potash Quantities			Kinds of Nitrogen		
	Nil	20 lb. per acre	40 lb. per acre	Nil	20 lb. per acre	40 lb. per acre	Blood Meal	Cyana-mide	Sulphate of Ammonia
Yield per acre lb. dry weight	501·8	515·7	526·6	517·5	509·1	517·4	522·6	517·9	522·9
Standard Error lb.	9·9			9·9			12·1		
Yield per cent of mean ..	97·5	100·2	102·3	100·5	99·0	100·5	100·3	99·4	100·3
Standard Error per cent. ..	1·9			9·9			2·3		

REPORT OF THE BIOCHEMIST.

Staff:—The Biochemist proceeded on leave on March 11th, and returned to duty on December 21st. During his absence the work of the division was carried out by Mr. B. N. Sastri, the Research Assistant.

Advisory:—The remarkable feature of the year has been the increase in the calls made on the department to visit estates and to report on their method of tea manufacture. 4 factories were visited by the Biochemist in January and later visits were made to 36 factories in 34 estates in the various tea districts in the Island. Usually the main object of these visits was to report on the general aspects of tea manufacture but in a few factories problems such as the following were investigated:—

(1) Withering and withering installations.
(2) Tea Drying.
(3) Ventilation of fermenting and rolling rooms.
(4) Taints in teas.
(5) Marshall-Boustead cooled rollers, (*T. Q.* 1931, p. 88.).

In addition to advisory correspondence and visits to factories, many samples of tea were received in the laboratory for moisture determination, such samples amounting to 415 during the year. In this connection it should be pointed out that while the division is quite willing to carry out moisture determinations and also to report on samples relevant to some particular problem, it will not undertake to give reports on teas in general. This can be done far better by the tea brokers, who employ professional tasters, and who constitute the final arbiters in the matter of tea quality for this department itself. Without doubt the officers of the division are becoming acquainted with the various characteristics of teas and are willing to help the planting community in this respect, but the department must not be looked upon as a tea tasting establishment. To do so is to put the division in a false position and occupy the time of the officers which could otherwise be devoted to research work.

The Gawthropp patent gear for the automatic control of the roller pressure cap was compared with a hand-controlled roller in the factory at St. Coombs.

In addition to the publication of the last article on "Tea Fermentation", in *The Tea Quarterly*, the preparation and delivery of an address during the Second Conference on "Factors in Tea Manufacture", a "Handbook of Factory Information" was prepared by the division for distribution to those present at the Conference, and as a guide to people visiting the factory. The demand for this little booklet has been so great that the publication of a revised copy is contemplated.

During his stay in England, the Biochemist spent a short time visiting various tea brokers' establishments in London, Mincing Lane tea auctions, and a firm of blenders and he wishes to express his thanks to all those who were so kind as to interest themselves in his visits, and went to a great deal of trouble to make these visits informative. In special I should like to thank

Messrs. Wilson Smithett & Co., Ltd., Charles Hope & Son., Sanderson & Co., and Twining & Co., Ltd.

A discussion on tea manufacture with the Haputale P. A. was attended at Haputale in January.

Experimental Machinery:—The experimental rollers were tried out in January, but the smooth roller tables were found to be not quite satisfactory, and new tables were fitted on to the rollers. The experimental sifter and drying machine were also fixed up, and, after some necessary alterations and modifications, daily manufacture was carried out in order to compare the action of the experimental machinery with that of the usual factory machinery. This period also served to train the operatives in the technique of manipulating the machinery and the leaf, an important factor in the success of any factory's make. Satisfactory teas can be made by means of the small-scale machinery, although conditions vary somewhat from those existing in the usual rollers. This difference is most marked in relation to the temperature developed during rolling, the temperature rise in the small mass of leaf used in the experimental rollers being very small. The experimental drier is not quite satisfactory yet, and needs further modification before it can be considered efficient, and one drier is not sufficient to cope with the leaf resulting from two rollers.

Factory Experiments:—A programme of factory experiments was drawn up and the methods of carrying them out was outlined at the beginning of the year. Several of these experiments were carried out, but others had to be postponed owing to the pressure of other work, such as visits to factories, attention to samples sent in, and a need for economy in the expenditure on factory work. The work done is outlined below:—

(1) *Manurial Experiments.*—Leaf harvested on the manurial experiment plots by the Soil Chemistry division was sent in to the experimental section of the factory for manufacture each time of plucking. The leaf sent in represented (a) crop obtained from tea bushes which had received a liberal supply of nitrogen in the form of manure, (b) crop obtained from tea bushes which had received no nitrogen in the form of manure, and which formed the control plots.

The leaf was sent down to the factory in separate bags, manufactured into tea under similar conditions, graded, and samples sent to tasters for their valuation and report. At the same time samples of these teas were analysed in the laboratory, but so far no significant difference in the quality of the teas has been found which could be ascribed to the manurial treatment. The leaf from the nitrogen treated bushes tends to wither more rapidly than that from the control plots, and this phenomenon will be kept under observation.

FERMENTATION EXPERIMENTS.

(a) *Influence of period during which leaf is fermented on the tea produced.*—Rolled leaf was put out to ferment and samples were taken and dried after the passing of definite time periods between zero time and 23 hours, the whole experiment being repeated daily for 14 days. At the end of this period the various samples were bulked and samples sent to various

tasters for their report. A fermenting period between 3½ and 4 hours for the first dhool gave the best results in general according to the taster's report. Chemical analysis of the teas confirms previous results that fermentation is accompanied by an initial rapid decrease in the soluble extract obtained from the tea and in the tannin content of the tea. This decrease slowed down after 4 hours' fermentation under the conditions obtaining during these experiments. The liquors obtained from the various samples increased in strength and colour up to the fourth hour of fermentation, after which a loss of strength was observed, and prolonged fermentation resulted in leaf giving deep muddy liquors, but flat teas; briskness and pungency being lost as a result of a long fermentation.

(b) *Effect of drying out of the leaf during fermentation.*—A series of experiments was carried out in which leaf was allowed to ferment under conditions which led to surface drying. Leaf ferments unevenly under such conditions and this results in a mixed infusion on brewing. The difference observed, however, was not so marked as was expected.

(c) *Effect of thickness of spreading on fermentation.*—Leaf spread to a thickness of 1½ to 2 inches gave the best results, that spread to 3 inches deep gave dull infusion and poor liquors, remarked upon as "sweaty". The brightest infusions were obtained with a 2¼ inch depth, but the liquors were reported on as lacking in "point". An appreciable increase in the temperature of the leaf was observed when the leaf was heaped to a greater depth than 1½ inches, as will be seen from Table I, the maximum temperature being attained in about 2 hours, after which it remained constant at this level for at least 1½ hours.

TABLE I.

Rise of Temperature observed in fermenting leaf

Thickness of Spread	Average Room Temperature	Period of Fermentation	Rise of Temperature		
			Max.	Aver.	Min.
¾ in.	66°F	3 hrs.	1	½	½
1½ ,,			5	4	3
2¼ ,,			8	7	6
3 ,,					

(d) *Influence of the nature of the surface on which the leaf ferments.*—Glass, asbestos, wood, cement, and lead surfaces were tested out; a cement surface proved to be the most satisfactory, while lead resulted in teas giving liquors reported as having a 'brassy' taste, and glass, teas with a liquor possessing a 'dry or woody' character.

TEA DRYING.

Harler (*Q. J. I. T. A.*, 1928, 1930) points out that teas fired in a dryer with an exhaust temperature of 140°F or over under the normal working conditions tend to case-harden and possess poor keeping qualities, but when fired under conditions giving an exhaust temperature of 120°F, the teas

obtained are brisk and do not show any sign of stewing. He points out that the proper exhaust temperature can be attained by

(1) Altering fan speeds.
(2) Changing the load on the trays.
(3) Altering the temperature of the ingoing air.

Visits to various estates have shown that there is a tendency to high firing in factories in Ceylon resulting in case-hardening of the tea which is consequently of poor keeping quality. Observations made confirm Harler's statement concerning the relation between firing temperatures and keeping qualities, and further that uneven firing is often due to uneven temperatures in different parts of the drying machine. Such irregular temperatures may exist in spite of a fairly steady inlet temperature.

Moisture absorption by fired teas during grading and storage.—Experiments have shown that fired teas absorb moisture readily during the process of picking and grading, the amount absorbed depending on the humidity of the grading room. The air of the sorting room should not exceed 65% saturation and it is advisable to maintain a wet and dry bulb thermometer in the room as a check on the air conditions.

Storage of teas.—Experiments carried out to test the keeping quality of tea packed in different ways have demonstrated that tea rapidly deteriorates in storage, the liquors losing their briskness and being reported as flat.

Moisture Content of Fresh Leaf.—The daily determination of the moisture content of the green leaf entering the factory for a whole year has been concluded, and a similar routine started on withered leaf. The maximum moisture content determined was 87·4 per cent and the minimum 66·8 per cent. When the figures for withered leaf have been completed an accurate record of the moisture content of fresh and withered leaf obtained for manufacture will be available for a whole year.

In conclusion, I wish to thank Messrs. Forbes and Walker Ltd., for reporting on the numerous tea samples sent to them for examination, and to Messrs. Lee, Hedges & Co., Ltd., Mackwoods Ltd., Colombo Commercial Co., Ltd. and Gordon Frazer & Co., Ltd., for examining special samples of experimental teas. The reports they submitted on the samples sent to them have been of great help in our experiments and are keenly appreciated.

I also wish to thank Mr. J. A. Rogers, the Superintendent and his factory staff for help readily given, and for granting facilities for obtaining leaf material for experimentation.

D. I. EVANS,
Biochemist.

LIBRARY

A comprehensive library upon Scientific and Agricultural subjects is an absolute necessity to a Research Institution such as the Tea Research Institute. The provision of the necessary books and publications is of itself not sufficient unless the library is systematically catalogued, indexed and arranged to allow of its contents being readily available to members of the staff.

The installation of the library in its permanent quarters necessitated the consideration of its proper disposal and policy. It was recognised that a systematic subject catalogue was necessary if the fullest use was to be made of the information available with the minimum of searching; consequently it was decided to adopt the Classification Decimale of the Institut International de Bibliographie as a basis for classification. This system has a number of advantages over older and apparently simpler arrangements, the chief of which are that material dealing with related subjects is brought together, and that expansion is allowed for without necessitating any alteration in the marking of books or indices in the future.

The work of classification has occupied a large amount of time. Not only had new incoming books and titled papers to be indexed and arranged but the whole accumulation of past years had to be worked through. Considerable progress has been made with the work. All new material has been registered and classified on arrival and most of the older material has now been indexed. The subject index at present contains over 2,500 cards and the author index a somewhat smaller number.

Shelving accommodation was originally provided for approximately 1,100 volumes. This has been found to be insufficient and a further stack of shelves for 800 volumes was erected at the end of the year. An extension of the index card cabinet has also been made.

Our exchange list has been revised and extended; it now includes the names of 67 institutions which regularly send us their publications in exchange for our own. Much valuable material has been obtained through this source.

Seventy-three volumes have been bound during the year. A considerable reduction in our binding charges has been obtained without sacrificing the quality of the material or workmanship.

With the funds available for the library it is impossible to purchase all the important current journals dealing with the various sciences having a direct bearing on agricultural research. Nor is such purchase necessary owing to the existence of other research institutions and libraries in Ceylon, willing to co-operate by loaning journals of particular interest. In the absence of definite information concerning the contents of the other libraries, much time was frequently lost in making enquiries concerning the location of particular journals which officers desired to consult, or by writing to England for a copy of a paper which might have been consulted in Ceylon had its location been known. By the courtesies of the Directors of Government Departments, Research Institutes and other libraries in Ceylon, lists were obtained of the periodical publications received by various scientific

libraries. These have been brought together and published as "A List of Foreign Periodicals and Publications in the Libraries of Ceylon". Our thanks are tendered to those who so willingly supplied the information which made the compilation of that list possible. A limited number of copies is still available for distribution.

The Institute would be glad to receive any copies of old books, pamphlets or photographs of historical or scientific interest dealing with tea cultivation for which their owners have no further use.

C. H. GADD,
I/C Library.

THE TEA RESEARCH INSTITUTE OF CEYLON.

BALANCE SHEET AS AT 31ST DECEMBER, 1931.

LIABILITIES.

			Rs. Cts.
GOVERNMENT OF CEYLON :—			
Loan @ 6% per annum secured by Mortgage	Rs. 1,000,000·00		
Less Repayments to date	,, 58,026·72	Rs. 941,973·28	
Add Accrued Interest		,, 14,129·60	956,102·88
RESERVE FOR SUPERINTENDENT'S FURLOUGH PAY AND PASSAGE ...		...	4,542·00
DEPRECIATION RESERVE ACCOUNT :—			
Balance as at 31st December, 1930		,, 22,659·00	
Added as per Income and Expenditure Account for year ended 31st December, 1931.		,, 53,654·92	
		,, 76,313·92	
Add Sale Proceeds of Old Car		,, 300·00	76,613·92
SUNDRY CREDITORS :—			
As per Schedule (since paid)		...	5,132·64
SURPLUS ACCOUNT :—			
At 31st December, 1930		,, 556,449·26	
Excess of Income over Expenditure		,, 96,787·32	653,236·58
		Rs.	1,695,628·02

ASSETS.

			Rs. Cts.
PROPERTY :—			
At 31st December, 1930 ...		Rs. 691,186·63	
Expenditure 1931 ...		,, 34,011·75	725,198·38
BUILDINGS, LINES, FURNITURE ETC. :—			
At 31st December, 1930 ...		,, 706,663·39	
Expenditure 1931 ...		,, 91,866·80	798,530·19
MACHINERY AND TOOLS :—			
At 31st December, 1930		,, 99,710·67	
Expenditure 1931		,, 693·30	100,403·97
EXPERIMENTAL MACHINERY :—			
At 31st December, 1930		,, 3,111·56	
Expenditure 1931		,, 5,032·22	8,143·78
MOTOR CAR ...		...	5,300·30
CEYLON ASSOCIATION IN LONDON	£111.15.10 @ 1/6		1,490·55
JEREMIAH LYON & COMPANY :—			
As per Director's Estimate			763·23
SUPERINTENDENT'S ACCOUNT, ST. COOMBS			3,051·76
STOCK-IN-TRADE :—			
20,731 lbs. Tea 929 lbs Inferior }	Since sold		17,496·76
SUNDRY DEBTORS :—			
Research Staff		Rs. 1,380·16	
Controller of Finance and Supply (December Tea Cess)		,, 25,000·45	
Empire Marketing Board Claimable Amount		,, 5,201·40	
Junior Staff Provident Fund		,, 15·00	31,597·01
PREPAID INSURANCE			750·00
CASH :—			
At Banks		,, 2,716·70	
In hand and Stamps		,, 185·39	2,902·09
		Rs.	1,695,628·02

We have audited the books of the Institute kept by the Planters' Association at Kandy in which are incorporated the Estate Returns. We have not audited the Estate Accounts.

The allocations of Capital Expenditure, and of Research Revenue expenditure as made by the Director and sanctioned by the Chairman have been accepted by us.

Subject to the foregoing, we certify that in our opinion the above Balance Sheet is a full and fair statement properly drawn up so as to exhibit a true and correct view of the state of the Institute's affairs according to the information and explanations afforded to us, and as shown by the books of the Institute kept at Kandy.

Colombo, 25th February, 1932.

FORD, RHODES, THORNTON & Co.,
Chartered Accountants. } *Auditors.*

Dr. ESTATE WORKING ACCOUNT FOR THE YEAR ENDED 31ST DECEMBER, 1931. Cr.

EXPENDITURE.	Rs. Cts.	Rs. Cts.	INCOME.		Rs. Cts.
To Estate Revenue Expenditure	Rs. 69,365·97		By Tea Sales	113,629 lbs.	115,159·00
,, Charges Export Duty, Etc.	,, 5,227·65	74,593·62	,, ,, Inferior	2,360 ,,	
,, Balance		40,565·38			
		Rs. 115,159·00			Rs. 115,159·00

Dr. INCOME AND EXPENDITURE STATEMENT AS AT 31ST DECEMBER, 1931. Cr.

	Rs. Cts.			Rs. Cts.
To Administration of the Board :—			By Balance from Estate Working Account	40,565·38
Planters' Association of Ceylon	6,000·00		,, Tea Cess	341,499·67
Secretary ...	2,400·00		,, Rent of Caddy	45·00
Travelling Expenses of Board Members ...	2,270·82		,, Interest	709·38
Postages ...	271·26		,, Empire Marketing Board	5,032·22
Stationery ...	656·49			
Advertising ...	435·00			
Telephone, Trunk Calls and Address ...	114·55			
Telegrams, Commission etc.	391·84			
Printing ...	293·13			
Legal Charges ...	100·50			
Auditors' Fee and expenses	401·81			
Sundry Expenses ...	92·89			
Conference ...	356·20	13,784·49		
,, Personal Emoluments of Scientific Staff :—				
Director ...	21,290·30			
Mycologist ...	16,500·00			
Agricultural Chemist ...	13,324·19			
Biochemist ...	12,978·07			
Entomologist ...	12,637·10			
Plant Physiologist ...	9,550·00	86,279·66		
Carried over :—		Rs. 100,064·15	Carried over :—	Rs. 387,851·65

THE TEA RESEARCH INSTITUTE OF CEYLON.

Dr. **INCOME AND EXPENDITURE STATEMENT AS AT 31ST DECEMBER, 1931.**—*(Contd.)* **Cr.**

		Rs. Cts.	Rs. Cts.
Brought forward :—			100,064·15
To Laboratories :—			
Sub. Staff Salaries	...	13,363·19	
Lab. Peons	...	1,518·59	
Nettle Grub	...	7,342·92	
Insurance	...	1,541·39	
Equipment	...	11,575·50	
Furniture and Alterations		1,044·53	
Library	...	1,469·71	
Publications	...	774·15	38,629·98
,, Field and Factory Experiments			4,282·53
,, Laboratory Offices :—			
Clerks	...	2,181·91	
Peons	...	299·67	
Stationery	...	810·51	
Postages	...	347·03	
Telephone Rent	...	353·27	3,992·39
,, Travelling of Staff :—			
Officers' Expenses	...	2,529·48	
Insurance of Car	...	176·67	
Taxes	...	70·00	
Drivers' Wages	...	840·33	
Drivers' Batta	...	340·00	
Running Expenses	...	1,792·45	5,748·93
,, Maintenance of Roads and Buildings :—			
Roads and Bridges	...	2,733·70	
Laboratory	...	763·95	
Senior Staff Buildings	...	1,155·47	
Junior Staff Buildings	...	618·70	
Clerks' Houses	...	198·66	
Misc. Buildings	...	452·34	5,922·81
Carried over :—			Rs. 387,851·65

	Rs. Cts.
Brought forward :—	Rs. 387,851·65
Carried over :—	Rs. 158,640·79

Dr. **INCOME AND EXPENDITURE STATEMENT AS AT 31ST DECEMBER, 1931.**—*(Contd.)* **Cr.**

	Rs. Cts.	Rs. Cts.		Rs. Cts.
Brought forward :—		158,640·79	Brought forward :—	387,851·65
To Sundries Shared with Estate :—				
Electric Light and Power	4,539·62			
Engine Room Staff ...	1,325·07			
Tappal Cooly and Fees ...	165·00			
Telephone Operator ...	530·00			
Scavenging ...	934·18			
Superintendent's Furlough and Passage ...	908·40			
Superintendent's Salary ...	1,530·00	9,932·27		
,, Upkeep of Grounds :—				
Garden Coolies ...	304·67			
Miscellaneous Expenditure	623·09	927·76		
,, Contingencies :—				
Incidentals ...	448·86			
Ceylon Planters' Provident Society	4,313·95			
Sub. Staff Provident Fund, J.S.	753·80			
Sub. Staff Provident Fund, Clerks	273·52			
Sub. Staff Bonus ...	156,42			
Passages ...	4,451·22			
Ceylon Nursing Association	65·00	10,467·77		
,, Loan Interest Account		57,440·82		
,, Depreciation		53,654·92		
,, Balance				
Excess of Income over Expenditure		96,787·32		
		Rs. 387,851·65		Rs. 387,851·65

THE TEA RESEARCH INSTITUTE OF CEYLON.

STATEMENT SHOWING COMPOSITION OF FIXED ASSETS AND DEPRECIATION RESERVE ACCOUNT AS AT 31ST DECEMBER, 1931.

			Rate of Depreciation	Depreciation Provided 1931	Balance of Depreciation 1930	Total Depreciation to 31st Dec. 1931.
1. PROPERTY :—	Rs. Cts.	Rs. Cts.		Rs. Cts.	Rs. Cts.	Rs. Cts.
Legal and Preliminary Expenses	30,308·10					
St. Coombs Estate ...	600,000·00					
New Clearings ...	58,570·94					
Extensions ...	36,276·84					
Water Supply ...	42·50	725,198·38	Nil	—	—	—
2. BUILDINGS, LINES, FURNITURE, ETC. :—						
BUILDINGS Factory	133,799·52					
Pump House	2,857·76					
Supdt's Bungalow	51,324·12					
Senior Staff	186,430·08					
Junior Staff	79,492·84					
Sundry	85,504·32					
Laboratory	206,992·18	746,400·82	5%	37,320·04	12,688·00	50,008·04
Bungalow Site	454·00					
Architect's Fees 5 and 6 Bungalows	1,491·67	1,945·67	Nil	—	—	—
FURNITURE Sundry ...	...	31,875·19	10%	3,187·51	—	3,187·51
Electrical Installation ...	...	6,193·24	10%	619·32	—	619·32
Telephone ...	...	5,632·99	Nil	—	—	—
Laboratory Equipment ...	...	6,482·28	10%	648·22	—	648·22
		798,530·19		41,775·09	12,688·00	54,463·09
3. MACHINERY AND TOOLS	100,403·97					
4. EXPERIMENTAL MACHINERY	8,143·78	108,547·75		10,854·76	9,971·00	20,825·76
5. MOTOR CAR ...	...	5,300·30	25% after adjustment for sale of Old Car	1,025·07	—	1,025·07
			Amount realised on sale of Old Car	—	—	300·00
			Rs.	53,654·92	Rs. 22,659·00	Rs. 76,613·92

Notes.

1. The balances on Buildings Account at 31st December, 1930, have been amalgamated in the books as shown above.
2. Depreciation was not provided on all Assets for 1930, and the above rates for 1931 are as approved by the Committee.

FORD, RHODES, THORNTON & Co.,
Chartered Accountants. } *Auditors.*

Colombo, 25th February, 1932.

St. Coombs Tea Sales, 1931.